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Minerals Yearbook

1976

Volume II

AREA REPORTS: DOMESTIC



Prepared by staff of the
BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • Cecil D. Andrus, Secretary

BUREAU OF MINES

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.

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Foreword

The Federal Government, through the Minerals Yearbook and its predecessor volumes, has reported annually on mineral industry activities for 95 years. This edition discusses the performance of the worldwide mineral industry during 1976. In addition to statistical data, the volumes provide background information to assist in interpreting the year's developments. Content of the individual volumes follows:

Volume I, Metals, Minerals, and Fuels, contains chapters on virtually all metallic, nonmetallic, and mineral fuel commodities important to the domestic economy. In addition, it includes a general review chapter on the mineral industries, a chapter on mining and quarrying trends, and a statistical summary.

Volume II, Area Reports: Domestic, contains chapters on the mineral industry of each of the 50 States, the U.S. island possessions in the Pacific Ocean and the Caribbean Sea, and the Commonwealth of Puerto Rico. This volume also has a statistical summary, identical to that in Volume I.

Volume III, Area Reports: International, contains the latest available mineral data on more than 130 foreign countries and discusses the importance of minerals to the economies of these nations. A separate chapter reviews the international minerals industry in general and its relationship to the world economy.

The Bureau of Mines continually strives to improve the value of its publications to its users. Therefore, the constructive comments and suggestions of readers of the Yearbook will be welcomed.

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 Technical Data Services. The Minerals Yearbook staff of that office 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 co-operating organizations:

- Alabama: Geological Survey of Alabama.
- Alaska: Alaska Department of Natural Resources.
- Arizona: Arizona Bureau of Mines.
- Arkansas: Arkansas Geological Commission.
- California: California Department of Conservation, Division of Mines and Geology.
- Colorado: Division of Mines of the State of Colorado.
- Connecticut: Connecticut Geological and Natural History Survey.
- Delaware: Delaware Geological Survey.
- Florida: Bureau of Geology, Department of Natural Resources.
- Georgia: Georgia Department of Natural Resources, Geologic and Water Resources Division.
- Hawaii: Hawaii Department of Land and Natural Resources.
- Idaho: Idaho Bureau of Mines and Geology.
- Illinois: Illinois State Geological Survey.
- Indiana: Geological Survey, Indiana Department of Natural Resources.
- Iowa: Iowa Geological Survey.
- Kansas: State Geological Survey of Kansas.
- Kentucky: Geological Survey of Kentucky.
- Louisiana: Louisiana Geological Survey.
- Maine: Bureau of Geology of Maine.
- Maryland: Maryland Geological Survey.
- Massachusetts: State Geologist of the Commonwealth of Massachusetts.
- Michigan: Geological Survey Division of the Michigan Department of Natural Resources.
- Mississippi: Mississippi Geological, Economic, and Topographical Survey.

- Missouri: Division of Geology and Land Survey, Department of Natural Resources.
- 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: New Jersey Division of Natural Resources, Bureau of Geology and Topography.
- New York: New York State Museum and Science Service.
- North Carolina: Division of Earth Resources, North Carolina Department of Natural and Economic Resources.
- North Dakota: North Dakota Geological Survey.
- Oklahoma: Oklahoma Geological Survey.
- Oregon: Department of Geology and Mineral Industries.
- Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources.
- Puerto Rico: Department of Natural Resources; Economic Development Administration (Fomento).
- South Carolina: South Carolina Geological Survey, State Development Board.
- South Dakota: South Dakota State 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: Geological and Natural History Survey of Wisconsin.
- Wyoming: Geological Survey of Wyoming.

Albert E. Schreck, *Editor-in-Chief*

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Statistical Summary

By Staff, Office of Technical Data Services

This chapter summarizes data on crude mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Included also are tables that show the principal 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 normally 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 pro-

duction of auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. In the cases of 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 on 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 adjustment made to compensate for changes in the purchasing power of the dollar.

**Table 1.—Value of crude mineral production¹
in the United States, by mineral group**

(Million dollars)

Year	Mineral fuels	Nonmetals except fuels	Metals	Total
1972	22,061	6,482	3,642	32,185
1973	25,012	7,413	4,362	36,787
1974	40,937	² 8,639	² 5,501	² 55,077
1975 ²	47,559	9,516	5,191	62,266
1976	52,545	10,547	6,086	69,178

¹Revised.

²Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Mineral production¹ in the United States

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MINERAL FUELS								
Asphalt and related bitumens, native: Bituminous limestone, sandstone, gilsonite	2,088,687	\$8,464	2,021,165	\$16,666	1,901,715	\$17,888	2,011,500	\$17,647
Carbon dioxide, natural	1,184,966	259	966,118	237	1,070,024	279	1,356,884	298
Coal:								
Bituminous and lignite ^a	591,738	5,049,612	603,406	9,502,347	648,438	12,472,486	678,685	13,189,481
Pennsylvania anthracite	6,880	90,260	6,617	144,695	6,203	198,481	6,228	209,234
Helium:								
Crude	2,568	30,696	184	2,208	384	4,008	585	7,020
High-purity	16,121	647	18,105	745	19,915	754	19,928	18,928
Natural gas	22,647,549	4,894,072	21,600,522	6,573,402	20,108,661	8,945,062	19,952,438	11,871,776
Natural gas liquids:								
Natural gasoline and cycle products	187,390	668,784	168,152	1,107,158	151,872	876,698	149,879	985,442
LP gases	447,833	1,166,267	447,746	1,890,789	444,438	1,897,894	437,246	2,292,647
Petroleum (crude)	3,360,993	13,067,905	3,202,585	21,580,549	3,056,779	23,116,059	2,976,180	24,229,540
Total mineral fuels	XX	25,012,000	XX	40,937,000	XX	147,559,000	XX	52,545,000
NONMETALS (EXCEPT FUELS)								
Abrasive stones ^a	3,466	667	3,134	717	2,953	1,060	2,696	1,404
Asbestos	160,086	16,288	109,091	13,393	96,664	14,220	114,842	23,683
Barite	1,104	16,668	1,106	16,822	1,318	21,200	1,234	23,689
Boron minerals	1,225	113,648	1,185	128,306	1,172	198,772	1,246	184,952
Bromine	418,250	67,131	482,094	171,715	407,163	113,126	439,558	107,663
Calcium chloride	609,300	17,581	739,100	24,552	594,400	25,047	648,979	32,889
Cement:								
Portland	82,718	1,810,992	75,983	1,992,695	65,215	2,015,625	69,168	2,330,402
Masonry	64,957	119,547	9,271	111,106	2,863	11,301	3,267	189,564
Clays	64,351	354,058	60,794	423,542	49,047	424,556	52,389	528,745
Diatomite	608,906	36,083	664,303	50,693	573,000	45,812	631,000	54,982
Fluorspar	2,884	W	W	W	8,487	W	W	W
Feldspar	701,900	12,830	762,723	111,396	789,898	111,738	739,684	17,581
Garnet (abrasive)	248,601	17,981	201,116	14,297	189,913	10,888	188,970	17,927
Gem stones ^a	22,772	2,981	24,484	2,550	17,204	1,690	24,565	3,740
Gypsum	NA	2,739	NA	4,589	NA	NA	NA	8,907
Iron	13,568	56,650	11,993	52,894	9,751	44,654	11,980	59,888
Magnesium compounds from seawater and brines (except for metal)	21,090	365,849	21,606	473,685	19,133	523,805	20,229	609,010
Magnesium compounds from seawater and brines (except for metal)	853,907	77,733	907,492	96,742	W	W	W	W

STATISTICAL SUMMARY

Mica:	177	6,082	137	5,475	135	5,219	127	5,686
Scrap	30,000	15	20,000	10	5,000	3	5,000	8
Sheet	543,683	5,591	555,000	7,024	512,000	7,282	553,000	9,397
Perlite	42,137	288,667	45,686	501,429	48,816	1,122,184	49,241	945,365
Phosphate rock	2,603	112,613	2,552	159,148	2,501	223,098	2,500	202,635
Potassium salts	3,937	8,881	3,937	9,121	3,892	11,203	4,134	10,466
Pumice	559	4,961	424	4,238	625	4,776	750	8,213
Pyrites	43,910	306,103	46,536	360,763	41,030	368,063	44,191	430,959
Salt	983,629	1,359,370	904,546	1,421,237	789,436	1,416,346	885,156	1,774,030
Sand and gravel	8,722	94,385	4,059	137,486	4,328	182,620	5,216	259,538
Sodium carbonate (natural)	672	11,597	684	16,411	667	27,667	663	32,655
Sodium sulfate (natural)	1,060,124	1,990,463	1,043,542	2,186,155	*901,393	*2,120,286	901,660	2,221,000
Stones	7,438	138,578	7,398	241,066	6,077	304,843	5,860	299,999
Sulfur, Frasch process	1,246,534	9,144	1,289,592	9,623	*964,609	*8,929	1,092,433	9,902
Talc, soapstone, pyrophyllite	101,519	930	85,121	776	80,562	124,281	124,281	14,032
Tripoli	365	9,464	341	10,120	330	13,761	304	14,032
Vermiculite								
Value of items that cannot be disclosed: Aplite, natural and slag cement (1973), graphite, iodine, kyanite, lithium minerals, magnesite, greensand marl, olivine, staurolite, wollastonite, and values of nonmetal items indicated by W	XX	28,926	XX	34,125	XX	157,180	XX	169,491
Total nonmetals	XX	7,413,000	XX	*8,639,000	XX	*9,516,000	XX	10,547,000

METALS

Antimony ore and concentrate	545	688	661	2,040	886	2,131	283	600
Bauxite	1,879	26,635	1,949	25,663	1,772	25,083	1,958	26,645
Copper (recoverable content of ores, etc.)	1,717,940	2,044,346	1,597,002	2,468,964	1,413,366	1,814,763	1,605,586	2,234,975
Gold (recoverable content of ores, etc.)	1,175,750	115,000	1,126,886	180,009	1,052,252	169,928	1,048,037	131,340
Iron ore, usable (excluding byproduct iron sludge)	90,654	1,163,710	84,985	1,388,447	75,695	1,620,599	76,697	1,860,102
Lead (recoverable content of ores, etc.)	603,024	196,465	663,370	298,742	621,464	267,230	609,546	281,610
Manganese ore (35% or more Mn)	239	W	W	W	W	W	W	W
Manganiferous ore (5% to 35% Mn)	203,055	2,171	272,908	2,323	*159,225	*1,413	256,633	2,260
Mercury	185,097	621	2,189	617	1,165	23,133	2,806	2,806
Molybdenum (content of concentrate)	18,272	*217,721	118,163	234,658	105,170	259,328	114,527	333,494
Nickel (content of ore and concentrate)	31,273	13,780	16,518	W	16,937	W	16,469	W
Rare-earth metal concentrates	37,484	95,883	33,762	159,018	84,938	154,424	34,328	149,328
Silver (recoverable content of ores, etc.)	W	W	W	W	W	W	W	W
Tin	W	W	W	W	W	W	W	W
Titanium concentrate:								
Ilmenite	804,355	20,128	755,338	23,715	702,252	26,946	617,896	27,578
Rutile	9,045	1,212	946	986	W	W	W	W
Tungsten ore and concentrate	7,059	19,154	7,336	37,413	5,490	29,090	5,869	37,266

Table 2.—Mineral production¹ in the United States—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued								
Uranium (recoverable content of U ₃ O ₈)	25,803	\$167,718	23,227	\$192,560	22,886	\$276,102	25,146	\$404,830
Vanadium (recoverable in ore and concentrate)	4,377	26,611	4,870	38,266	4,743	49,329	7,376	81,279
Zinc (recoverable content of ores, etc.)	478,850	197,861	499,872	358,908	469,355	366,097	484,513	358,541
Value of items that cannot be disclosed:								
beryllium, magnesium chloride for magnesium metal, manganese residue, platinum-group metals (crude), zircon concentrate, and values indicated by W	XX	54,004	XX	73,828	XX	127,459	XX	153,452
Total metals	XX	4,362,000	XX	5,501,000	XX	5,191,000	XX	6,086,000
Grand total	XX	36,787,000	XX	55,077,000	XX	62,266,000	XX	69,178,000

^eEstimate. ^fRevised. NA Not available. W Withheld to avoid disclosing individual company confidential data, included with "Value of items that cannot be disclosed." XX Not applicable.

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

²Includes a small quantity of anthracite mined in States other than Pennsylvania.

³Grindstones, pulpstones, grinding pebbles, sharpening stones, and tube mill liners.

⁴Excludes abrasive stone, bituminous limestone, and soapstone, all included elsewhere in table.

Table 3.—Minerals produced in the United States and principal producing States in 1976

Mineral	Principal producing States, in order of quantity	Other producing States
Antimony ore and concentrate	Mont. and Idaho.	
Apelite	Va.	
Asbestos	Calif., Vt., Ariz., N.C.	
Asphalt (native)	Tex., Utah, Ala., Mo.	
Barite	Nev., Mo., Ark., Ga.	Idaho, Ill., Mont., Tenn.
Bauxite	Ark., Ala., Ga.	
Beryllium concentrate	Utah	Ariz. and S. Dak.
Boron minerals	Calif.	
Bromine	Ark. and Mich.	
Calcium-chloride	Mich. and Calif.	
Carbon dioxide (natural)	N. Mex., Colo., Calif., Utah.	
Cement	Calif., Tex., Pa., Mich.	Ala., Ariz., Ark., Colo., Fla., Ga., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Maine, Md., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N.C., Ohio, Okla., Oreg., S.C., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wis., Wyo.
Clays	Ga., Ohio, Tex., N.C.	All other States except Alaska, R.I., Vt.
Coal	Ky., W. Va., Pa., Ill.	Ala., Alaska, Ariz., Ark., Colo., Ga., Ind., Iowa, Kans., Md., Mo., Mont., N. Mex., N. Dak., Ohio, Okla., Tenn., Tex., Utah, Va., Wash., Wyo.
Copper (mine)	Ariz., Utah, N. Mex., Mont.	Calif., Colo., Idaho, Maine, Mich., Mo., Nev., Pa., Tenn., Wash.
Diatomite	Calif., Nev., Wash.	Kans. and Oreg.
Emery	N.Y.	
Feldspar	N.C., Conn., Ga., Calif.	Ariz., Colo., Maine, Okla., S. Dak., Wyo.
Fluorspar	Ill., Ky., Tex., Nev.	Ariz., Mont., Utah.
Garnet, abrasive	Idaho and N.Y.	
Gold (mine)	S. Dak., Nev., Utah, Ariz.	Alaska, Calif., Colo., Idaho, Mont., N. Mex., Oreg., Tenn., Wash.
Graphite	Tex.	
Gypsum	Mich., Calif., Tex., Iowa.	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mont., Nev., N. Mex., N.Y., Ohio, Okla., S. Dak., Utah, Va., Wash., Wyo.
Helium	Kans., Okla., Tex.	Ariz. and N. Mex.
Iodine	Mich.	
Iron ore	Minn., Mich., Calif., Wyo.	Ariz., Colo., Ga., Mo., Mont., Nev., N.Y., Pa., S. Dak., Tex., Utah, Wis.
Kyanite	Va. and Ga.	
Lead (mine)	Mo., Idaho, Colo., Utah.	Alaska, Ariz., Calif., Ill., Maine, Mont., Nev., N. Mex., N.Y., Okla., Va., Wash., Wis.
Lime	Ohio, Pa., Mo., Mich.	Ala., Ariz., Ark., Calif., Colo., Conn., Fla., Hawaii, Idaho, Ill., Ind., Iowa, Kans., Ky., La., Md., Mass., Minn., Miss., Mont., Nebr., Nev., N.J., N. Mex., N.Y., N. Dak., Okla., Oreg., S. Dak., Tenn., Tex., Utah, Va., Wash., W. Va., Wis., Wyo.
Lithium minerals	N.C., Nev., Calif.	
Magnesite	Nev.	
Magnesium chloride	Tex.	
Magnesium compounds	Mich., Calif., N.J., Fla.	Del., Miss., Tex., Utah.
Manganiferous ore	Minn., N. Mex., S.C.	
Manganiferous residuum	N.J.	
Marl, greensand	N.J.	
Mercury	Nev. and Calif.	
Mica, scrap	N.C., Ala., N. Mex., Ga.	Ariz., Conn., Pa., S.C.
Molybdenum	Colo., Ariz., N. Mex., Utah.	Calif. and Nev.
Natural gas	Tex., La., Okla., N. Mex.	Ala., Alaska, Ariz., Ark., Calif., Colo., Fla., Ill., Ind., Kans., Ky., Md., Mich., Miss., Mo., Mont., Nebr., N.Y., N. Dak., Ohio, Pa., Tenn., Utah, Va., W. Va., Wyo.
Natural gas liquids	Tex., La., Okla., N. Mex.	Ala., Alaska, Ark., Calif., Colo., Fla., Ill., Kans., Ky., Mich., Miss., Mont., Nebr., N. Dak., Pa., S. Dak., Utah, W. Va., Wyo.
Nickel	Oreg.	
Olivine	N.C. and Wash.	
Peat	Mich., Ind., Pa., Ill.	Calif., Colo., Fla., Ga., Iowa, Maine, Md., Mass., Minn., Mont., N.J., N.Y., N. Dak., Ohio, S.C., Wash., Wis.
Perlite	N. Mex., Ariz., Calif., Idaho.	Colo. and Nev.

Table 3.—Minerals produced in the United States and principal producing States in 1976 —Continued

Mineral	Principal producing States, in order of quantity	Other producing States
Petroleum, crude	Tex., La., Calif., Okla	Ala., Alaska, Ariz., Ark., Colo., Fla., Ill., Ind., Kans., Ky., Mich., Miss., Mo., Mont., Nebr., Nev., N. Mex., N.Y., N. Dak., Ohio, Pa., S. Dak., Tenn., Utah, Va., W. Va., Wyo.
Phosphate rock	Fla., Idaho, N.C., Tenn	Ark., Calif., Mo., Mont., Utah, Wyo.
Platinum-group metals	Alaska	
Potassium salts	N. Mex., Utah, Calif.	
Pumice	Oreg., Ariz., Calif., N. Mex	Colo., Hawaii, Idaho, Mont., Nev., Okla., Utah.
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., Mich	All other States.
Silver (mine)	Idaho, Ariz., Colo., Mont	Alaska, Calif., Ill., Maine, Mich., Mo., Nev., N. Mex., N.Y., S. Dak., Tenn., Utah, Va., Wash.
Sodium carbonate (natural)	Wyo. and Calif.	
Sodium sulfate (natural)	Calif., Tex., Utah.	
Staurolite	Fla.	
Stone	Pa., Ill., Tex., Mo	All other States except Del. and N. Dak.
Sulfur (Frasch)	Tex. and La.	
Talc, soapstone, pyrophyllite	Vt., Mont., N.Y., Tex	Ark., Calif., Ga., Nev., N.C., Oreg., Va., Wash.
Tin	Colo. and N. Mex.	
Titanium concentrate	Fla., N.J., N.Y.	
Tripoli	Ill., Okla., Ark., Pa.	
Tungsten concentrate	Calif., Colo., Nev	Ariz., Idaho, Mont., Oreg., Utah, Wash.
Uranium	N. Mex., Wyo., Utah, Colo	Tex. and Wash.
Vanadium	Ark., Colo., Idaho, Utah	N. Mex.
Vermiculite	Mont. and S.C.	
Wollastonite	N.Y.	
Zinc (mine)	Mo., Tenn., N.Y., Colo	Alaska, Ariz., Calif., Idaho, Ill., Ky., Maine, Mont., Nev., N.J., N. Mex., Okla., Pa., Utah, Va., Wash., Wis.
Zircon concentrate	Fla.	

Table 4.—Value of mineral production in the United States and principal minerals produced in 1976

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	\$1,029,536	20	1.49	Coal, petroleum, cement, stone.
Alaska	625,188	23	.90	Petroleum, sand and gravel, natural gas, stone.
Arizona	1,726,621	10	2.50	Copper, molybdenum, sand and gravel, cement.
Arkansas	535,448	25	.77	Petroleum, bromine, natural gas, cement.
California	3,483,373	4	5.04	Petroleum, natural gas, cement, sand and gravel.
Colorado	1,110,166	18	1.60	Petroleum, molybdenum, coal, natural gas.
Connecticut	34,318	47	.05	Stone, sand and gravel, feldspar, lime.
Delaware	1,837	50	(²)	Sand and gravel, magnesium compounds, clays, gem stones.
Florida	1,652,232	11	2.39	Phosphate rock, petroleum, cement, stone.
Georgia	428,479	28	.62	Clays, stone, cement, sand and gravel.
Hawaii	42,252	44	.06	Stone, cement, sand and gravel, pumice.
Idaho	210,246	33	.30	Silver, phosphate rock, zinc, lead.
Illinois	1,581,165	12	2.29	Coal, petroleum, stone, sand and gravel.
Indiana	607,321	24	.88	Coal, cement, stone, petroleum.
Iowa	216,027	32	.31	Cement, stone, sand and gravel, coal.
Kansas	1,213,853	16	1.75	Petroleum, natural gas, natural gas liquids, stone.
Kentucky	3,114,589	5	4.50	Coal, petroleum, stone, natural gas.
Louisiana	8,652,107	2	12.51	Petroleum, natural gas, natural gas liquids, sulfur.
Maine	40,364	45	.06	Sand and gravel, cement, zinc, stone.
Maryland	184,918	36	.27	Coal, stone, cement, sand and gravel.
Massachusetts	69,850	43	.10	Stone, sand and gravel, lime, clays.
Michigan	1,543,516	13	2.23	Iron ore, petroleum, cement, natural gas.
Minnesota	1,218,030	15	1.76	Iron ore, sand and gravel, stone, lime.
Mississippi	449,862	26	.65	Petroleum, natural gas, cement, sand and gravel.
Missouri	785,160	21	1.13	Lead, cement, stone, iron ore.
Montana	636,289	22	.92	Petroleum, coal, copper, cement.
Nebraska	123,365	39	.18	Petroleum, cement, sand and gravel, stone.
Nevada	233,683	31	.34	Copper, gold, sand and gravel, barite.
New Hampshire	17,579	48	.03	Sand and gravel, stone, clays, gem stones.
New Jersey	119,886	40	.17	Sand and gravel, stone, zinc, titanium concentrate.
New Mexico	2,510,127	8	3.63	Petroleum, natural gas, copper, natural gas liquids.
New York	427,964	29	.62	Cement, stone, salt, sand and gravel.
North Carolina	203,339	34	.29	Stone, phosphate rock, sand and gravel, lithium minerals.
North Dakota	244,105	30	.35	Petroleum, coal, natural gas, natural gas liquids.
Ohio	1,435,896	14	2.08	Coal, petroleum, lime, stone.
Oklahoma	2,789,974	7	4.03	Petroleum, natural gas, natural gas liquids, coal.
Oregon	112,566	41	.16	Stone, sand and gravel, cement, nickel.
Pennsylvania	3,041,186	6	4.40	Coal, cement, stone, lime.
Rhode Island	6,400	49	.01	Sand and gravel, stone, gem stones.
South Carolina	125,455	38	.18	Cement, stone, clays, sand and gravel.
South Dakota	101,580	42	.15	Gold, cement, stone, sand and gravel.
Tennessee	439,714	27	.64	Coal, stone, zinc, cement.
Texas	18,143,204	1	26.23	Petroleum, natural gas, natural gas liquids, cement.
Utah	1,043,981	19	1.51	Petroleum, copper, coal, uranium.
Vermont	35,097	46	.05	Stone, asbestos, sand and gravel, talc.
Virginia	1,160,645	17	1.68	Coal, stone, cement, lime.
Washington	187,222	35	.27	Cement, coal, sand and gravel, stone.
West Virginia	3,498,001	3	5.06	Coal, natural gas, petroleum, natural gas liquids.
Wisconsin	132,453	37	.19	Sand and gravel, stone, iron ore, cement.
Wyoming	1,851,599	9	2.68	Petroleum, sodium compounds, coal, natural gas.
Total	69,178,000	--	100.00	

¹Incomplete total.
²Less than 1/2 unit.

Table 5.—Value of mineral production per capita and per square mile in 1976, by State

State	Area (square miles)	1976 popula- tion (thous- ands)	Value of mineral production				
			Total (thous- ands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,609	3,665	\$1,029,536	19,949	14	281	17
Alaska	586,412	382	625,188	1,066	49	1,637	5
Arizona	113,909	2,270	1,726,621	15,158	19	761	11
Arkansas	53,104	2,109	535,448	10,083	26	254	19
California	158,693	21,520	3,483,373	21,950	12	162	26
Colorado	104,247	2,583	1,110,166	10,649	24	430	13
Connecticut	5,009	3,117	34,318	6,851	31	11	48
Delaware	2,057	582	1,837	893	50	3	50
Florida	58,560	8,421	1,652,232	28,214	9	196	22
Georgia	58,876	4,970	428,479	7,278	30	86	32
Hawaii	6,450	887	42,252	6,530	32	48	38
Idaho	83,557	831	210,246	2,516	41	253	20
Illinois	56,400	11,229	1,581,165	28,085	10	141	28
Indiana	36,291	5,302	607,321	16,735	17	115	30
Iowa	56,290	2,870	716,027	5,898	33	75	34
Kansas	82,264	2,310	1,213,853	14,755	20	525	12
Kentucky	40,395	3,428	3,114,589	77,103	3	909	8
Louisiana	48,523	3,841	8,652,107	178,309	1	2,253	2
Maine	33,215	1,070	40,364	1,215	47	38	41
Maryland	10,577	4,144	184,918	17,483	16	45	39
Massachusetts	8,257	5,809	69,850	8,459	29	12	47
Michigan	58,216	9,104	1,543,516	26,514	11	170	24
Minnesota	84,068	3,965	1,218,030	14,489	21	307	16
Mississippi	47,716	2,354	449,862	9,428	27	191	23
Missouri	69,686	4,778	785,160	11,267	23	164	25
Montana	147,138	753	636,289	4,324	35	845	10
Nebraska	77,227	1,553	123,365	1,597	45	79	33
Nevada	110,540	610	233,683	2,114	43	383	14
New Hampshire	9,304	822	17,579	1,889	44	21	45
New Jersey	7,836	7,336	119,886	15,299	18	16	46
New Mexico	121,666	1,168	2,510,127	20,631	13	2,149	3
New York	49,576	18,084	427,964	8,632	28	24	44
North Carolina	52,586	5,469	203,339	3,867	37	37	42
North Dakota	70,665	643	244,105	3,454	39	380	15
Ohio	41,222	10,690	1,435,896	34,833	7	134	29
Oklahoma	69,919	2,766	2,739,974	39,903	6	1,008	7
Oregon	96,981	2,329	112,566	1,161	48	48	37
Pennsylvania	45,333	11,862	3,041,186	67,085	5	256	18
Rhode Island	1,214	927	6,400	5,272	34	7	49
South Carolina	31,055	2,848	125,455	4,040	36	44	40
South Dakota	77,047	686	101,530	1,318	46	148	27
Tennessee	42,244	4,214	439,714	10,409	25	104	31
Texas	267,338	12,487	18,143,204	67,866	4	1,453	6
Utah	84,916	1,228	1,043,981	12,294	22	850	9
Vermont	9,609	476	35,097	3,653	38	74	35
Virginia	40,817	5,032	1,160,645	28,435	8	231	21
Washington	68,192	3,612	187,222	2,746	40	52	36
West Virginia	24,181	1,821	3,498,001	144,659	2	1,921	4
Wisconsin	56,154	4,609	132,453	2,359	42	29	43
Wyoming	97,914	890	1,851,599	18,910	15	4,748	1
Total ²	3,615,055	213,956	69,178,000	19,136	XX	323	XX

XX Not applicable.

¹Incomplete total.²Excludes Washington, D.C., with an area of 67 square miles and a population of 702,000 (which had no mineral production).

Table 6.—Mineral production¹ in the United States, by State

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA								
Cement:								
Masonry	2,425	\$13,074	314	\$11,322	262	\$10,253	314	\$13,671
Portland	2,896	55,820	2,190	61,990	1,968	62,599	2,134	70,366
Clays	2,824	8,738	2,995	13,238	2,231	9,077	2,239	10,325
Coal (bituminous)	19,320	211,695	19,324	432,036	22,644	600,767	21,537	611,069
Iron ore (usable)	371	11,408	W	W	W	W	W	W
Lime	581	14,050	1,054	22,346	985	29,404	1,009	32,753
Natural gas	11,971	4,307	27,865	20,704	37,814	32,598	41,427	40,806
Petroleum (crude)	11,577	41,772	13,323	113,808	13,477	136,541	14,706	155,437
Sand and gravel	9,805	13,870	12,454	19,120	9,232	17,376	12,023	20,933
Stone	20,043	40,117	23,773	40,231	22,232	61,515	23,332	65,429
Value of items that cannot be disclosed: Asphalt (native), bentonite, cement (slag 1973), clay (benzoinite), mica (scrap), natural gas liquids, salt, stone (dimension 1973-74), talc (1973-76), and values indicated by W	XX	8,155	XX	9,891	XX	8,543	XX	8,748
Total	XX	413,056	XX	764,746	XX	968,973	XX	1,029,536
ALASKA								
Barite	W	W	20	401	2	30	706	W
Coal (bituminous)	694	57	700	57	706	57	60	60
Gem stones	NA	695	NA	1,461	NA	2,419	NA	2,968
Gold (recoverable content of ores, etc.)	7,107	2	9,146	2	14,980	2	22,387	6
Lead (recoverable content of ores, etc.)	6	19,488	2	21,919	160,270	48,402	166,072	64,602
Natural gas	131,007	261,877	70,603	347,408	69,534	364,630	69,398	318,789
Petroleum (crude)	72,323	19,913	43,644	22,964	46,145	25,730	74,208	204,733
Sand and gravel	14,999	1	2	3	W	W	W	W
Silver (recoverable content of ores, etc.)	1	12,741	5,484	12,947	8,377	26,649	6,727	20,092
Stone	5,967	5	12	W	11	60	--	--
Tin	5	W	W	W	W	W	W	W
Value of items that cannot be disclosed: Copper (1974), mercury (1973-74), natural gas liquids, platinum-group metals, uranium (1973), and values indicated by W	XX	14,156	XX	11,453	XX	12,718	XX	14,019
Total	XX	323,938	XX	418,603	XX	480,745	XX	625,188

See footnotes at end of table.

Table 6.—Mineral production in the United States, by State — Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARIZONA								
Clays	3,117	\$459	199	\$622	129	\$483	928	\$361
Coal (bituminous)	3,241	W	6,448	W	6,986	W	10,420	W
do. — short tons	927,271	1,108,453	868,783	1,327,678	813,211	1,044,162	1,024,421	1,425,984
Gold	NA	NA	1,500	NA	NA	5,000	NA	4,000
Gold (recoverable content of ores, etc.)	102,848	10,660	90,340	14,470	86,790	13,854	102,062	12,790
Gypsum	158	669	1,059	478	1,117	419	189	529
Lead	763	248	1,059	478	1,117	131	338	156
Lead (recoverable content of ores, etc.)	365	7,019	422	9,071	512	12,464	546	16,115
Mica (scrap)	W	W	2	82	2	W	W	W
Molybdenum (content of concentrate)	37,657	59,372	28,346	57,087	25,080	61,413	31,073	89,148
Natural gas	125	23	224	45	208	53	262	4
do. — million cubic feet	804	3,103	740	8,885	633	58	56	2,724
Petroleum (crude)	853	715	846	865	856	1,294	802	1,340
Pumice	27,440	38,503	23,417	41,906	17,222	36,490	518,131	5,134
Sand and gravel	7,199	18,416	6,356	23,935	6,286	27,783	7,431	33,596
Sliver (recoverable content of ores, etc.)	4,265	9,469	4,932	11,479	3,404	11,080	4,147	13,621
Stone	8,427	3,482	9,699	6,964	8,655	6,751	9,501	7,080
Zinc (recoverable content of ores, etc.)	XX	XX	XX	XX	XX	XX	XX	XX
Value of items that cannot be disclosed: Asbestos, beryl concentrate (1976), cement, clays (fire, 1973; ball and common, 1976), feldspar, fluorspar, (1973, 1976), helium (high purity), iron ore, perlite, pyrite, salt (1975-76), sand and gravel (industrial, 1976), tungsten, and values indicated by W	XX	49,827	XX	55,716	XX	63,666	XX	79,229
Total	XX	1,304,988	XX	1,562,284	XX	1,288,428	XX	1,726,621
ARKANSAS								
Bauxite	1,686	28,884	1,731	23,597	1,543	22,956	1,667	24,481
Clays	3,446	\$1,412	984	1,597	995	2,202	1,647	3,896
Coal (bituminous)	434	5,806	455	9,673	488	16,000	384	19,310
do. — short tons	NA	NA	NA	60	NA	70	NA	85
Gem stones	W	W	4	W	(6)	W	W	W
Iron ore	177	2,742	187	3,189	116	8,848	182	4,900
Lime	157,529	25,985	123,975	32,284	116,287	40,334	109,588	55,052
Natural gas	204	861	199	1,344	196	1,860	208	1,422
do. — million cubic feet	449	1,688	418	2,491	407	2,377	408	2,440
Natural gasoline and cycle products	18,016	70,618	16,527	122,817	16,133	149,336	18,097	174,636
LP gases	12,465	20,625	14,878	29,922	12,415	25,794	5,147,786	528,848
Petroleum (crude)	12,465	20,625	14,878	29,922	12,415	25,794	5,147,786	528,848
Sand and gravel	12,465	20,625	14,878	29,922	12,415	25,794	5,147,786	528,848

STATISTICAL SUMMARY

Stone	16,223	26,209	20,381	38,905	17,419	38,796	417,701	439,713
Value of items that cannot be disclosed: Abrasive stones, barite, bromine, cement, clays (kaolin, 1973), gypsum, phosphate rock (1975-76), sand and gravel (industrial, 1976), stone (dimension, 1976), soapstone, tripoli, vanadium, and values indicated by W								
Total	XX	XX	XX	XX	XX	XX	XX	XX

CALIFORNIA

Asbestos	105,663	10,886	58,331	5,697	W	W	78,390	15,706
Barite	11	152	4	W	1	W	1,246	184,852
Boron minerals	1,225	113,648	1,185	128,306	1,172	158,772	1,246	184,852
Cement	9,395	201,892	8,264	210,520	7,327	282,684	7,897	293,698
Clays	2,723	6,853	2,497	7,626	37,373	37,373	2,295	13,970
Copper (recoverable content of ores, etc.)	369	440	194	300	344	441	375	522
Diatomite	W	W	W	W	W	31,186	386	37,372
Gemstones	NA	220	NA	220	NA	NA	NA	231
Gold (recoverable content of ores, etc.)	3,647	357	5,049	807	9,606	1,551	10,392	1,802
Gypsum	1,778	5,834	1,716	6,642	1,446	6,332	1,647	7,897
Lead (recoverable content of ores, etc.)	44	14	35	16	66	28	54	25
Lime	632	13,602	600	14,877	595	18,626	638	28,324
Magnesium compounds from seawater and bitterns (partly estimated)	184,105	19,233	163,847	18,356	W	W	W	W
Mercury	1,219	349	1,311	370	W	W	296	36
Natural gas	449,369	167,615	365,354	160,756	319,308	222,816	354,334	339,074
Natural gas liquids:								
LP gases	6,865	23,475	5,709	26,104	4,347	29,543	4,626	31,655
Natural gasoline and cycle products	5,329	19,824	5,095	29,296	4,481	20,568	4,151	25,487
do	21	373	14	322	W	W	W	W
Petroleum (crude)	336,075	1,045,193	323,003	1,710,350	322,199	1,943,048	326,021	2,005,377
Pumice	768	3,237	909	3,219	348	2,762	705	3,245
Rare-earth metal concentrates	W	W	34,284	15,798	W	W	W	W
Salt	1,507	15,633	W	W	W	W	W	W
Sand and gravel	117,470	176,286	105,191	176,213	88,445	168,248	96,592	202,272
Silver (recoverable content of ores, etc.)	56	143	42	197	80	353	57	249
Stone	48,838	77,175	45,709	91,891	38,152	72,740	32,377	75,352
Talc, soapstone, pyrophyllite	179,191	1,501	163,841	1,676	152,978	1,598	56,871	1,513
Zinc (recoverable content of ores, etc.)	20	8	8	6	206	161	170	126
Value of items that cannot be disclosed: Bromine (1973-75), calcium-magnesium chloride, carbon dioxide, cement (masonry, 1973), clays (ball and kaolin, 1975), feldspar, iron ore, lithium minerals, molybdenum, perlite, phosphate rock (1976), potassium salts, sodium carbonate and sulfate, tungsten concentrates, and values indicated by W								
Total	XX	XX	XX	XX	XX	XX	XX	XX

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
COLORADO								
Carbon dioxide	W		W		W		W	
Clays	794	\$1,710	663	\$1,588	229,382	\$1,101	317,720	\$1,976
Coal (bituminous)	6,233	46,190	6,896	64,677	480	4,479	9,437	144,364
Copper (recoverable content of ores, etc.)	3,123	3,716	3,012	4,657	3,560	4,571	2,431	3,384
Gem stones	NA	131	NA	155	145	NA	NA	142
Gold (recoverable content of ores, etc.)	63,422	6,203	52,083	8,320	55,483	8,960	50,764	6,362
Gypsum	151	568	191	800	185	782	215	984
Lime (recoverable content of ores, etc.)	28,112	9,159	24,609	11,074	27,088	11,648	26,749	12,358
Lead	137,725	3,371	198	3,815	198	4,577	185	4,406
Natural gas liquids:		24,304	144,629	28,926	171,629	44,624	183,972	88,307
Natural gasoline and cycle products	1,424	4,295	1,574	9,319	1,742	9,378	1,904	13,403
LP gases	1,978	6,488	2,560	14,190	4,821	22,803	6,505	38,249
Pet.	28	163	30	201	37	280	33	238
Petroleum (crude)	36,590	155,507	37,608	288,904	38,089	365,654	38,992	376,273
Sand and gravel	33,767	46,493	23,793	39,674	20,019	34,850	520,160	52,900
Silver (recoverable content of ores, etc.)	3,598	9,204	2,784	13,113	3,366	14,878	4,063	17,762
Stone	6,857	14,003	6,972	15,109	5,315	10,940	5,294	12,555
Uranium (recoverable content of U ₃ O ₈)	1,888	12,274	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.)	58,339	24,106	49,489	35,533	48,460	37,799	50,621	37,460
Value of items that cannot be disclosed: Cement, clays (bentonite, 1976), feldspar, fluorspar (1973-74), iron ore, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial, 1976), tin, tungsten, vanadium, and values indicated by W	XX	164,806	XX	215,264	XX	249,211	XX	319,043
Total	XX	581,691	XX	750,299	XX	1,968,073	XX	1,110,166
CONNECTICUT								
Clays	162	320	156	363	116	307	130	427
Feldspar	77,206	W	W	W	W	W	W	W
Gem stones	NA	16	NA	15	NA	1,013	NA	1,103
Lime	W	33	W	23	W	W	24	W
Mica, scrap	W	2	W	W	W	W	W	W
Sand and gravel	7,806	12,788	6,345	11,272	4,900	10,040	6,414	12,978
Stone	9,682	21,305	8,457	21,134	7,322	20,117	6,016	17,598

Value of items that cannot be disclosed: Mica (sheet, 1974), and values indicated by W

XX	2,375	XX	1,430	XX	1,533	XX	2,212
XX	36,804	XX	35,362	XX	33,010	XX	34,318
DELAWARE							
15	9	14	8	9	6	11	8
NA	W	NA	2	NA	W	NA	W
3,408	3,678	2,396	3,763	976	1,900	1,117	1,829
XX	202	XX	W	XX	W	XX	W
XX	3,889	XX	*3,793	XX	*1,906	XX	*1,887
FLORIDA							
256	8,706	235	4,737	W	W	W	W
2,725	72,666	2,562	75,133	1,721	62,525	1,949	67,832
1,139	13,718	808	14,261	712	17,063	680	20,872
187	4,026	185	5,315	199	7,708	179	7,798
33,857	11,613	33,137	20,441	44,383	43,185	43,165	42,388
44	334	67	616	82	1,037	179	1,287
32,695	150,070	36,351	351,931	41,877	490,258	44,460	499,573
20,167	21,415	24,372	33,400	13,237	20,199	13,204	19,164
61,375	103,595	54,560	100,378	39,071	73,372	38,606	74,412
9,045	1,212	6,446	996	W	W	W	W
XX	213,695	XX	437,287	XX	1,060,153	XX	919,106
XX	601,100	XX	1,043,895	XX	1,775,500	XX	1,652,232
GEORGIA							
67	2,126	40	1,304	W	W	W	W
1,201	25,124	1,150	31,535	828	25,822	930	30,085
*7,721	*160,419	*7,692	*203,986	6,156	195,300	7,471	273,145
51,523	W	W	W	W	W	186	6,152
(*)	4	6	6	(*)	5	W	W
4,976	6,781	4,980	9,639	5,102	8,318	4,835	8,837
40,841	97,596	40,321	105,532	30,084	91,157	31,855	98,606
38,000	114	33,850	102	27,400	82	W	W

Total

DELAWARE

Clays ----- thousand short tons.
Gem stones -----
Sand and gravel ----- thousand short tons.
Value of items that cannot be disclosed: Other nonmetals and values indicated by W

Total

FLORIDA

Cement: -----
Masonry ----- thousand short tons.
Portland ----- do.
Lime ----- do.
Natural gas ----- million cubic feet.
Peat ----- thousand short tons.
Petroleum ----- thousand 42-gallon barrels.
Sand and gravel ----- thousand short tons.
Stone ----- do.
Titanium concentrates (rutile) ----- short tons.
Value of items that cannot be disclosed: Clay (kaolin, 1974), kyanite (1973), magnesium compounds, natural gas liquids, phosphate rock, rare-earth metal concentrate, staurolite, stone (dimension), titanium concentrate (ilmenite), zircon concentrate, and values indicated by W

Total

GEORGIA

Cement: -----
Masonry ----- thousand short tons.
Portland ----- do.
Clays ----- do.
Coal (bituminous) ----- do.
Feldspar ----- short tons.
Peat ----- thousand short tons.
Sand and gravel ----- do.
Stone ----- do.
Talc ----- short tons.

See footnotes at end of table.

Table 6.—Mineral production in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quan- tity	Value (thousands)	Quan- tity	Value (thousands)	Quan- tity	Value (thousands)	Quan- tity	Value (thousands)
GEORGIA—Continued								
Value of items that cannot be disclosed: Barite, bauxite, fire clay (1973-74), iron ore, kyanite, mica (scrap), rare-earth metal concentrate (1973-74), titanium concentrate (1973-74), zircon concentrate (1973-74), and values indicated by W	XX	\$10,405	XX	\$10,996	XX	\$12,203	XX	\$11,904
Total	XX	305,479	XX	363,100	XX	333,387	XX	428,479
HAWAII								
Cement:	16	537	14	706	13	762	11	663
Masonry	453	13,213	487	16,405	456	19,942	328	17,747
Portland	NA	W	NA	W	NA	W	NA	W
Gem stones	6	238	6	221	6	250	NA	W
Lime	354	611	385	792	318	912	330	636
Pumice, pumicite, volcanic ash	753	2,012	990	2,379	871	2,460	573	1,634
Sand and gravel	7,130	18,466	*7,638	*21,370	7,569	25,319	46,092	*21,193
Stone	XX	70	XX	169	XX	65	XX	379
Value of items that cannot be disclosed: Clays, salt (1973), stone (dimen- sion, 1974, 1976), and values indicated by W	XX	35,147	XX	42,042	XX	49,710	XX	42,252
Total	XX	35,147	XX	42,042	XX	49,710	XX	42,252
IDAHO								
Antimony ore and concentrate	322	406	445	W	W	W	133	W
Clays	42	277	39	\$10	30	284	284	W
Copper (recoverable content of ores, etc.)	3,623	4,114	2,841	4,393	3,192	4,099	3,362	4,630
Gem stones	NA	NA	NA	120	NA	120	NA	126
Gold (recoverable content of ores, etc.)	2,596	26	2,398	463	2,599	408	2,755	345
Lead (recoverable content of ores, etc.)	61,714	20,116	51,717	23,273	50,395	21,670	53,636	24,780
Pumice	80	110	108	182	111	187	53,636	24,780
Sand and gravel	8,393	10,246	7,665	10,484	6,881	19,768	86,549	W
Silver (recoverable content of ores, etc.)	13,620	34,540	12,466	56,572	13,868	61,297	11,561	50,292
Stone	2,972	8,096	3,523	9,863	3,316	8,362	43,462	49,122
Zinc (recoverable content of ores, etc.)	46,107	19,052	39,469	25,339	40,926	31,922	46,366	34,473

Value of items that cannot be disclosed: Barite (1974-76), cement, clays (fire clay and kaolin, 1974), garnet (abrasive), gypsum, iron ore (1973-75), lime, perlite, phosphate rock, sand and gravel (industrial, 1976), stone (dimension, 1976), tungsten concentrate, vanadium, and values indicated by W

XX	38,300	XX	72,854	XX	92,081	XX	74,924
XX	136,081	XX	208,558	XX	283,788	XX	210,246
Total							

ILLINOIS

Cement:									
Masonry	88	2,901	69	3,228	W	42,756	W	1,632	W
Portland	1,572	86,064	1,460	41,023	1,374	3,249	1,309	8,272	53,524
Clays*	1,758	3,613	1,587	3,744	1,966	871,377	58,239	925,968	3,272
do.	61,572	413,309	58,215	583,010	59,897	8,957	142,666	14,563	2
Coal (bituminous)	160,306	11,871	151,898	12,247	NA	2	NA	NA	W
Fluorspar	NA	2	NA	2	NA	2	NA	NA	W
Gem stones	541	176	493	222	W	1,008	1,556	1,533	2
Lead (recoverable content of ores, etc.)	1,583	573	1,436	574	1,440	1,511	87	763	1,638
Natural gas	72	1,037	96	1,412	96	26,272	26,272	267,449	87
Peat	30,669	132,490	27,553	244,395	26,067	273,182	38,784	87,152	87,152
Petroleum (crude)	43,649	62,029	43,705	68,668	39,000	130,104	61,362	141,543	W
Sand and gravel	66,653	114,068	63,231	121,763	60,640	W	W	W	W
Stone	5,250	2,169	4,104	2,947	W	W	W	W	W
Zinc (recoverable content of ores, etc.)									
Value of items that cannot be disclosed: Barite (1974-76), clay (filler), earth, copper (1974), lime, natural gas liquids, silver, tripoli, and values indicated by W	XX	45,306	XX	65,517	XX	74,937	XX	85,396	1,581,165
Total									

INDIANA

Cement:									
Masonry	W	W	W	W	W	12,263	396	14,970	896
Portland	W	2,668	1,092	1,947	1,994	63,077	2,430	73,492	2,430
Clays*	1,436	153,136	23,728	196,410	25,124	1,961	1,235	3,396	3,396
do.	25,253	38	176	25	346	280,180	25,369	312,990	312,990
Coal (bituminous)	276	38	176	25	346	139	132	132	132
Natural gas	276	38	176	25	346	139	132	132	132
Peat	51	475	71	946	76	48,313	4,630	50,421	1,716
Petroleum (crude)	5,312	20,822	4,919	42,402	4,632	48,321	4,630	50,421	4,630
Sand and gravel	27,731	35,015	26,077	35,556	21,641	35,524	25,584	45,521	45,521
Stone	432,288	497,652	431,081	64,106	28,947	63,350	28,450	72,205	72,205
Value of items that cannot be disclosed: Abrasive stone, gypsum, lime, sandstone (1973-74), and values indicated by W	XX	81,698	XX	97,198	XX	129,211	XX	94,358	94,358
Total									
XX	351,405	XX	440,890	XX	541,600	XX	607,321	607,321	607,321

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
IOWA								
Cement:								
Masonry	68	\$2,951	65	\$2,660	62	\$2,993	76	\$4,143
Portland	2,688	59,574	2,424	64,156	2,958	75,796	2,493	84,777
Clays	967	2,028	960	4,869	959	9,916	1,017	9,247
Coal (bituminous)	601	3,279	590	4,591	622	6,891	616	8,651
Gem stones	NA	W	NA	W	NA	W	NA	W
Gypsum	1,470	6,324	1,397	7,142	1,208	6,546	1,466	8,288
Sand and gravel	19,950	25,541	17,091	26,104	15,410	26,844	*15,208	*26,277
Stone	31,541	56,918	32,342	66,119	30,836	73,732	*30,272	*75,921
Value of items that cannot be disclosed: Lime, peat, sand and gravel (industrial, 1976), stone (dimension, 1976), and values indicated by W	XX	2,785	XX	4,079	XX	3,092	XX	4,694
Total	XX	158,800	XX	176,720	XX	195,740	XX	216,027
KANSAS								
Cement:								
Masonry	73	2,068	64	2,203	57	2,311	72	3,281
Portland	2,926	42,172	1,940	46,940	1,682	55,083	2,065	66,478
Clays	1,169	1,490	1,311	1,765	1,178	1,604	*1,064	*1,869
Coal (bituminous)	1,086	7,979	718	5,463	479	9,481	590	11,473
Halite	1,599	18,468	W	W	W	W	W	W
Crude	416	8,736	499	11,417	497	11,928	503	11,066
High-purity	410	8,199	38	535	W	W	W	W
Lime	893,118	138,621	886,762	147,206	843,626	145,103	829,170	348,251
Natural gas								
Natural gas liquids:								
LP gases	5,993	17,695	6,690	24,810	6,995	25,062	6,434	31,017
Petroleum (crude)	24,463	53,819	24,492	79,818	23,655	71,692	23,427	83,422
Salt ²	66,227	281,465	61,691	490,984	59,106	561,598	58,714	657,788
Sand and gravel	13,261	23,460	11,397	27,097	14,446	31,214	*13,010	*35,291
Stone	*13,384	12,653	*11,697	19,388	10,666	13,467	*12,291	*14,940
Value of items that cannot be disclosed: Stone (dimension, 1976), and values indicated by W	*13,384	*83,601	*17,869	34,869	15,307	35,860	*16,348	*38,228

Value of items that cannot be disclosed: Clays (bentonite, 1976), diatomite (1974-76), gypsum, pumice (1973-75), salt (brine), sand and gravel (industrial, 1976), stone (dimension, 1973, 1976), and values indicated by W

XX	3,973	XX	3,913	XX	6,418	XX	10,754
XX	646,299	XX	889,398	XX	970,611	XX	1,213,853

KENTUCKY

Clays ³	1,083	1,961	848	1,477	778	1,483	754	2,895
Coal (bituminous)	127,645	986,654	137,197	2,340,961	143,643	2,499,295	143,972	2,848,690
Natural gas	62,396	21,839	71,876	35,988	60,511	32,676	66,137	36,375
Petroleum (crude)	8,687	34,515	8,887	68,340	7,556	84,520	7,483	85,454
Sand and gravel	10,331	14,627	8,710	12,887	9,924	14,466	9,154	15,271
Stone	438,205	470,912	35,452	66,632	31,734	67,906	33,378	77,060
Zinc (recoverable content of ores, etc.)	273	113	--	--	41	32	59	44
Value of items that cannot be disclosed: Cement, clay (ball), fluorspar, lead (1975), lime, natural gas liquids, and stone (quartzite, 1973)	XX	34,141	XX	36,975	XX	38,481	XX	49,300
Total	XX	1,164,762	XX	2,563,210	XX	2,798,859	XX	3,114,589

LOUISIANA

Clays	979	1,329	770	1,425	531	1,132	513	1,158
Lime	897	16,301	796	17,665	485	12,484	W	W
Natural gas	8,242,423	1,846,303	7,753,631	2,380,365	7,090,645	2,999,179	7,006,596	3,223,034
Natural gas liquids:								
Natural gasoline and cycle products	47,906	167,037	35,860	234,954	31,308	178,980	27,078	151,683
LP gases	102,701	253,671	103,439	423,996	103,714	392,039	91,701	375,057
Petroleum (crude)	837,524	3,327,702	737,324	4,311,772	650,340	4,611,379	606,501	4,566,761
Salt	13,152	66,211	13,543	76,960	12,166	77,116	13,491	91,952
Sand and gravel	13,748	21,165	12,341	27,781	14,587	35,990	22,528	51,293
Stone	10,802	21,309	10,940	24,046	10,489	38,260	9,685	28,127
Sulfur (Frasch process)	3,329	W	3,426	W	2,672	W	2,445	W
Value of items that cannot be disclosed: Cement, gypsum, stone (miscellaneous, 1973-74), and values indicated by W	XX	98,082	XX	147,614	XX	166,266	XX	173,042
Total	XX	5,319,610	XX	8,146,578	XX	8,513,275	XX	8,652,107

MAINE

Clays	41	74	146	183	125	202	134	216
Copper	1,107	1,317	1,522	2,353	2,024	2,599	1,766	2,469
Gem stones	NA	W	NA	W	NA	W	NA	1,105
Lead (recoverable content of ores, etc.)	204	66	279	126	364	157	216	1,100

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MAINE—Continued								
Peat	5	\$177	4	\$194	4	\$207	5	\$173
Sand and gravel	13,583	10,804	8,755	10,673	9,875	11,403	5 ^{10,912}	5 ^{13,950}
Stone	1,212	3,829	1,481	4,255	4,253	49,741	1,443	4,609
Zinc (recoverable content of ores, etc.)	19,640	8,115	10,425	7,488	8,818	6,488	7,810	5,779
Value of items that cannot be disclosed: Cement, feldspar (1973), sand and gravel (industrial, 1976), silver, stone (dimension, 1975), and values indicated by W	XX	10,111	XX	11,079	XX	11,944	XX	11,973
Total	XX	33,498	XX	36,348	XX	36,741	XX	40,864
MARYLAND								
Clays ²	887	1,973	884	2,066	580	1,450	702	1,817
Coal (bituminous)	1,789	13,644	2,371	45,650	2,676	50,502	2,630	61,974
Germ stones	NA	W	NA	8	NA	W	NA	W
Lime	298	69	32	597	43	43	75	44
Natural gas	2	29	3	22	2	39	2	47
Peat	12,845	29,625	11,690	29,368	11,786	29,477	12,942	31,914
Sand and gravel	18,585	46,732	18,072	47,630	14,796	43,110	15,709	47,669
Stone	XX	39,227	XX	44,556	XX	39,882	XX	41,026
Value of items that cannot be disclosed: Cement, clay (ball), talc and soapstone (1973-74), and items indicated by W	XX	131,907	XX	172,880	XX	164,919	XX	184,918
Total	XX	131,907	XX	172,880	XX	164,919	XX	184,918
MASSACHUSETTS								
Clays	217	404	218	370	124	228	126	238
Germ stones	NA	W	NA	5	NA	W	NA	W
Lime	2	78	3	4,972	152	5,219	173	6,954
Peat	18,743	26,910	17,384	26,565	13,281	24,584	16,084	29,666
Sand and gravel	8,580	28,738	8,103	30,103	7,170	28,681	7,987	33,862
Stone	XX	3,547	XX	---	XX	166	XX	90
Value of items that cannot be disclosed: Nonmetals and values indicated by W	XX	59,682	XX	62,109	XX	58,846	XX	69,850
Total	XX	59,682	XX	62,109	XX	58,846	XX	69,850

MICHIGAN										
Cement:	247	6,185	217	6,309	183	6,429	218	8,370	W	
Masonry	6,242	123,442	5,903	140,513	4,573	131,324	4,931	145,381	W	
Portland	9,151	3,304	2,151	4,074	1,818	3,580	1,934	4,741	W	
Clays	72,221	85,943	67,012	103,601	73,690	94,618	43,707	60,840	W	
Copper (recoverable content of ores, etc.)	N/A	8	N/A	8	N/A	8	N/A	10	W	
Gem stones	1,382	8,538	1,432	7,258	1,224	5,936	1,337	9,842	W	
Gypsum	12,388	180,194	11,602	213,598	14,089	339,113	16,245	441,206	W	
Iron ore (usable)	1,545	26,055	1,528	30,036	1,434	36,540	1,456	39,686	W	
Lime	455,501	41,790	503,281	53,302	102,113	64,740	119,262	106,739	W	
Magnesium compounds from seawater and brine (except for metal)	44,579	17,495	69,133	34,843					W	
Natural gas									W	
Natural gas liquids:									W	
Natural gasoline									W	
LP gases									W	
Peat	372	1,189	466	3,089	656	3,294	3,504	19,725	W	
Petroleum (crude)	691	2,529	849	5,383	1,348	5,945	1,215	6,306	W	
Salt and gravel	232	2,172	244	3,311	245	3,206	300	3,714	W	
Silver (recoverable content of ores, etc.)	14,614	59,413	18,021	154,746	24,420	262,352	30,421	329,637	W	
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, iodine, and values indicated by W	4,818	53,732	4,445	62,055	4,020	66,353	4,219	79,740	W	
	62,407	73,972	60,027	82,617	47,051	73,397	47,403	78,455	W	
	850	2,175	643	3,028	632	2,795	311	1,352	W	
	45,886	60,494	47,479	72,748	39,946	73,800	41,485	82,331	W	
Total	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
	XX	789,022	XX	1,035,430	XX	1,291,653	XX	1,543,516	XX	XX

MINNESOTA										
Clays	5156	5233	W	NA	W	NA	W	NA	W	W
Gem stones	NA	14	NA	14	NA	14	NA	14	NA	15
Iron ore (usable)	62,614	782,197	W	59,422	W	949,678	W	49,167	W	47,374
Lime	170,371	W	W	225,560	W	W	W	108,749	W	103,389
Manganiferous ore (5% to 35% Mn)	37,935	W	W	20	W	471	W	13	W	26
Peat	7,581	39,498	W	36,720	W	42,370	W	33,898	W	53,456
Sand and gravel		20,411	W	8,301	W	22,041	W	6,864	W	7,567
Stone	XX	10,492	XX	XX	XX	11,792	XX	XX	XX	XX
Value of items that cannot be disclosed: Abrasive stones, cement (1973-75), clays (selected, 1973), lime, sand and gravel (industrial, 1976), and values indicated by W	XX	852,785	XX	XX	XX	1,026,366	XX	XX	XX	1,218,080
Total	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
	XX	789,022	XX	1,035,430	XX	1,291,653	XX	1,543,516	XX	1,543,516

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State —Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
MISSISSIPPI								
Clays -----								
Lime -----	2,075	\$9,082	2,013	\$10,468	1,592	\$10,605	1,487	\$8,849
Natural gas -----	W	W	70	1,393	53	1,060	57	1,248
do -----	99,706	22,846	78,787	23,242	74,345	36,875	70,762	50,241
Petroleum (crude) -----	56,102	213,747	50,779	309,753	46,614	310,346	46,072	328,957
Sand and gravel -----	14,251	17,383	14,989	19,487	14,372	23,098	*12,033	\$20,394
Stone -----	4,760	4,809	1,719	2,572	1,629	2,730	1,762	2,968
Value of items that cannot be disclosed: Cement, clays (selected, 1976), magnesium compounds, natural gas liquids, sand and gravel (industrial, 1976), stone (limestone 1973), and values indicated by W -----	XX	17,871	XX	24,240	XX	25,295	XX	37,205
Total -----	XX	281,738	XX	391,155	XX	410,009	XX	449,862
MISSOURI								
Barite -----	196	3,395	177	3,386	171	3,989	124	3,860
Cement -----								
Masonry -----	84	2,400	75	2,434	65	2,110	76	2,718
Portland -----	4,582	99,858	4,229	106,985	3,962	116,260	4,353	142,976
Clays -----	2,551	11,626	2,565	13,151	*21,68	*13,214	*2,133	*14,915
Coal (bituminous) -----	4,658	24,999	4,623	29,383	5,638	48,054	6,075	56,934
Copper (recoverable content of ores, etc.) -----	10,273	12,224	12,665	19,580	14,258	18,308	11,050	15,382
Iron ore (usable) -----	2,630	W	1,866	W	2,273	W	2,133	W
Lead (recoverable content of ores, etc.) -----	487,143	158,711	562,097	252,944	515,958	221,862	500,991	231,453
Lime -----	1,626	23,534	1,901	36,369	1,606	40,630	1,731	49,307
Natural gas -----	33	8	33	10	30	10	29	10
do -----	60	W	56	W	57	W	61	W
Petroleum (crude) -----	42	W	35	W	35	W	W	W
do -----	10,879	16,950	10,933	19,462	9,752	18,216	15,375	26,550
Phosphate rock -----	2,058	5,264	2,387	11,244	2,525	11,161	2,277	9,905
Sand and gravel -----	49,304	79,921	50,626	90,204	46,988	95,585	47,546	98,327
Silver (recoverable content of ores, etc.) -----	82,350	34,027	91,987	66,047	74,367	58,396	85,530	61,312
Stone -----								
Zinc (recoverable content of ores, etc.) -----								
Value of items that cannot be disclosed: Asphalt (native), clays (selected, 1974-75), and values indicated by W -----	XX	39,717	XX	39,850	XX	74,983	XX	70,406
Total -----	XX	512,634	XX	691,049	XX	722,728	XX	785,160

MONTANA

Antimony	W	219	1,998	W	2,189	W	273	813	150	318
Clays	W	10,725	90,298	W	54,961	W	22,054	111,579	192	W
Coal (bituminous and lignite)	W	132,496	187,494	W	202,728	W	87,959	112,940	26,231	128,584
Copper (recoverable content of ores, etc.)	NA	NA	NA	W	NA	W	NA	400	91,111	126,827
Gem stones	W	27,976	2,790	W	28,268	W	17,259	2,787	NA	170
Gold (recoverable content of ores, etc.)	W	12	57	W	30	W	18	W	24,075	3,017
Iron ore (usable)	W	176	176	W	154	W	205	88	18	43
Lead (recoverable content of ores, etc.)	W	210	3,028	W	226	W	221	5,188	92	5,980
Lime	W	299	13,240	W	54,873	W	40,784	17,638	224	18,941
Manganese ore and concentrate (35% or more Mn)	W	56,175	1	W	1	W	1	51	42,563	W
Natural gas	W	34,620	115,423	W	34,554	W	32,844	257,169	32,814	276,419
Peat	W	11,894	13,819	W	4,242	W	4,127	6,963	4,786	7,386
Petroleum (crude)	W	4,350	11,127	W	3,512	W	2,617	11,565	3,279	14,262
Sand and gravel	W	5,054	9,559	W	43,115	W	43,180	46,753	3,468	7,994
Silver (recoverable content of ores, etc.)	W	73	30	W	136	W	110	86	64	47
Stone (recoverable content of ores, etc.)	W	73	30	W	136	W	110	86	64	47
Zinc (recoverable content of ores, etc.)	W	73	30	W	136	W	110	86	64	47
Value of items that cannot be disclosed: Barite (1975-76), cement, fluorspar, gypsum, natural gas liquids, phosphate rock, pumice (1976) stone (diamonds, 1974-75), talc (1973-76), tungsten ore and concentrate, vermiculite, and values indicated by W	XX	26,962	XX	XX	33,881	XX	XX	37,252	XX	46,401
Total	XX	XX	385,295	XX	574,801	XX	XX	573,150	XX	636,289

NEBRASKA

Clays	158	286	182	414	195	416	195	416	149	345
Gem stones	NA	11	NA	691	NA	11	NA	11	NA	W
Lime	31	651	36	863	2,565	1,988	2,565	1,988	2,511	1,288
Natural gas	3,836	698	2,535	45,167	6,120	55,183	6,120	55,183	6,182	55,551
Petroleum (crude)	7,240	28,065	6,511	17,727	11,769	16,381	11,769	16,381	5,148	521,483
Sand and gravel	15,906	18,366	13,231	10,364	4,242	10,322	4,242	10,322	4,101	11,064
Stone	15,906	18,366	13,231	10,364	4,242	10,322	4,242	10,322	4,101	11,064
Value of items that cannot be disclosed: Cement, natural gas liquids, sand and gravel (industrial, 1976), and values indicated by W	XX	21,816	XX	23,497	XX	27,784	XX	27,784	XX	33,633
Total	XX	80,821	XX	98,634	XX	111,905	XX	111,905	XX	123,365

NEVADA

Barite	549	4,691	761	8,115	7947	11,533	7947	11,533	900	13,379
Clays	36	176	39	218	45	3186	45	3186	37	3174

See footnotes at end of table.

Table 6.—Mineral production in the United States, by State —Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEVADA—Continued								
Copper (recoverable content of ores, etc.)	93,702	\$111,505	84,101	\$130,021	81,210	\$104,274	58,160	\$80,958
Gem stones	NA	142	NA	400	NA	2,814	NA	1,300
Gold (recoverable content of ores, etc.)	260,437	25,473	298,754	47,723	332,814	53,746	287,962	36,087
Gypsum	1,154	3,662	843	2,959	558	2,375	792	3,884
Iron ore (usable)	119	W	139	W	109	1,017	W	W
Lead (recoverable content of ores, etc.)	698	W	1,785	803	2,976	1,280	582	269
Mercury	—	200	W	W	W	W	22,887	2,770
Petroleum (crude)	96	W	129	W	115	W	143	W
Pumice	W	W	W	W	W	W	388	763
Sand and gravel	12,448	14,614	8,786	14,515	8,056	16,848	9,871	20,106
Silver (recoverable content of ores, etc.)	624	1,595	872	4,108	1,609	7,111	784	3,410
Stone	3,595	5,429	2,186	4,203	41,829	4,524	41,904	45,975
Tungsten ore and concentrate	150	377	182	537	33	152	99	561
Zinc (recoverable content of ores, etc.)	—	—	3,405	2,445	5,496	4,287	1,438	1,064
Value of items that cannot be disclosed: Antimony (1973-74), cement, clays (selected, 1975-76), diatomite, fluorspar, lime, lithium minerals, magnesite, molybdenum, perlite, salt, stone (dimension, 1975-76), talc, and values indicated by W	XX	33,949	XX	41,329	XX	48,820	XX	57,983
Total	XX	201,813	XX	257,876	XX	258,917	XX	233,683
NEW HAMPSHIRE								
Clays	43	64	94	55	W	W	W	W
Gem stones	NA	42	NA	42	NA	5,160	NA	W
Sand and gravel	7,795	8,697	6,126	8,223	5,160	9,077	46,180	510,409
Stone	1,886	5,416	590	5,371	1,519	7,988	742	7,082
Value of items that cannot be disclosed	—	—	—	—	XX	92	XX	138
Total	XX	14,119	XX	13,691	XX	17,107	XX	17,579
NEW JERSEY								
Clays	183	666	104	524	67	372	61	381
Gem stones	NA	16	NA	16	NA	16	NA	17
Peat	44	514	31	603	29	686	22	568
Sand and gravel	19,040	43,098	17,924	47,292	13,012	39,640	12,420	39,439
Stone	15,902	45,585	15,749	52,456	11,821	42,381	11,234	39,012
Zinc (recoverable content of ores, etc.)	33,027	13,647	32,848	23,585	31,105	24,262	33,767	24,987

STATISTICAL SUMMARY

Value of items that cannot be disclosed: Lime (1973, 1976), magnesium compounds, manganese residue, greensand marl, stone (dimension), and titanium concentrate

	XX	10,490	XX	16,272	XX	16,345	XX	15,582
Total	XX	114,016	XX	140,748	XX	123,702	XX	119,886
NEW MEXICO								
Carbon dioxide	W	W	W	W	W	60	556,548	80
Clays	88	169	55	317	44	61	56	116
Coal (bituminous)	9,069	31,862	9,892	W	8,785	W	9,760	W
Copper (recoverable content of ores, etc.)	204,742	243,643	196,585	303,920	146,263	187,802	172,360	239,923
Gem stones	NA	70	NA	200	NA	200	NA	210
Gold (recoverable content of ores)	13,864	1,956	15,427	2,464	15,049	2,460	15,196	1,905
Gypsum	285	1,220	187	532	W	W	W	W
Helium (high-purity)	-	114	-	135	W	W	W	W
Iron ore (usable)	2,566	833	2,863	1,074	1,931	830	W	W
Lime (recoverable content of ores, etc.)	84	793	58	1,679	W	W	W	W
Mica	82,084	W	47,348	49,976	W	W	45,926	W
Manganese ore (5% to 35% Mn)	10	82	12	60	W	W	W	W
Metal scrap	1,218,749	287,989	1,244,779	390,861	1,217,430	498,059	1,230,976	695,501
Natural gas liquids	9,848	32,449	9,713	53,545	9,194	45,292	9,490	51,369
Natural gasoline and cycle products	29,652	74,427	30,271	120,781	30,214	122,065	32,654	180,577
LP gases	3	50	4	111	W	W	W	W
Peat	478	5,024	480	6,306	429	6,400	481	8,408
Petrolite	100,986	414,041	98,695	712,573	95,063	788,073	92,130	814,419
Potassium salts	2,168	91,996	2,102	123,588	2,081	179,924	2,083	165,354
Pumice	339	1,901	371	1,466	397	1,260	486	1,560
Salt	W	W	167	1,468	147	1,048	W	W
Sand and gravel	10,641	15,753	7,413	10,605	6,220	13,798	7,702	16,671
Silver (recoverable content of ores, etc.)	1,111	2,943	1,195	5,628	792	3,501	892	8,880
Stones	2,830	5,804	43,631	43,369	2,197	4,683	1,935	4,394
Uranium (recoverable content of U ₃ O ₈)	9,296	60,956	9,971	104,683	10,893	187,893	11,880	191,271
Zinc (recoverable content of ores, etc.)	12,327	5,094	13,764	9,397	11,015	8,592	W	W
Zinc (recoverable content of ores, etc.) that cannot be disclosed: Cement, clay (fire), fluor spar (1974-75), molybdenum, stone (dimension, 1974), tin, vanadium, and values indicated by W	XX	29,631	XX	77,755	XX	104,614	XX	184,492
Total	XX	1,306,590	XX	1,941,544	XX	2,091,541	XX	2,510,127
NEW YORK								
Clays	1,799	2,146	1,451	2,348	817	1,561	649	2,089

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NEW YORK—Continued								
Emery	2,893	W	W	W	W	W	W	W
Gem stones	NA	\$16	NA	\$16	NA	\$16	NA	\$16
Gypsum	325	3,369	364	2,942	NA	NA	NA	NA
Lead (recoverable content of ores, etc.)	2,804	751	3,076	1,802	8,027	1,802	8,136	1,476
Natural gas	4,599	1,990	4,990	2,745	7,628	5,645	9,235	10,486
Peat	11	166	38	181	22	377	852	684
Petroleum (crude)	967	5,412	896	9,588	875	10,893	857	10,497
Salt	5,202	42,364	6,464	57,109	5,718	57,344	6,755	66,437
Sand and gravel	29,944	41,396	30,614	44,882	22,158	44,844	27,881	56,132
Silver (recoverable content of ores, etc.)	84	94,698	88,207	87,724	31,715	80,929	28,136	75,040
Stone	44,998	94,698	38,207	87,724	31,715	80,929	28,136	75,040
Zinc (recoverable content of ores, etc.)	81,485	33,697	93,077	66,829	76,612	69,787	73,671	54,517
Value of items that cannot be disclosed: Cement, clay (ball), garnet (abrasive), iron ore, lime, mercury (1974-75), talc, titanium concentrate, wollastonite, and values indicated by W	XX	150,167	XX	162,205	XX	185,792	XX	180,423
Total	XX	375,866	XX	440,573	XX	397,728	XX	427,964
NORTH CAROLINA								
Clays ²	4,109	5,057	3,422	4,648	2,582	4,094	2,750	4,677
Feldspar	523,595	8,820	650,684	11,147	*468,401	*7,905	515,477	11,549
Gem stones	NA	40	NA	50	NA	50	NA	75
Mica:								
Scrap	106	4,423	76	3,679	75	3,265	70	3,793
Sheet								
Sand and gravel	15,897	19,327	12,784	20,844	W	W	5,000	2
Stone	38,762	80,065	34,762	75,142	28,308	69,327	30,877	18,287
Talc and pyrophyllite	95,883	1,094	110,978	993	*95,575	*1,605	113,754	82,462
Value of items that cannot be disclosed: Asbestos, cement, clay (kaolin), iron ore (1972-74), lithium minerals, olivine, phosphate rock, and values indicated by W	XX	28,104	XX	39,366	XX	51,479	XX	1,087
Total	XX	146,930	XX	155,869	XX	*153,385	XX	203,839
NORTH DAKOTA								
Coal (lignite)	6,906	14,398	7,463	16,351	8,515	27,010	11,102	41,507
Gem stones	NA	2	NA	2	NA	2	NA	2

Natural gas	27,703	5,457	31,206	6,210	24,786	5,701	31,470	10,699
--- million cubic feet.								
Peat	20,235	78,916	19,697	119,022	20,432	149,705	21,725	170,411
--- short tons.								
Petroleum (crude)	6,021	6,021	4,981	6,211	5,636	8,133	5,171	8,345
--- thousand barrels.								
Sand and gravel	W	W	35	115	30	153	--	--
--- thousand short tons.								
Stone	XX	7,129	XX	11,516	XX	10,800	XX	13,141
--- do.								
Value of items that cannot be disclosed: Clays, lime, natural gas liquids, salt, and values indicated by W	XX	111,853	XX	159,427	XX	201,504	XX	244,105
--- do.								
Total	XX	111,853	XX	159,427	XX	201,504	XX	244,105

OHIO

Cement:								
Masonry	176	5,641	188	5,227	136	4,576	155	7,288
Portland	3,456	73,362	2,884	73,815	2,364	70,268	2,130	65,656
--- do.	4,732	12,456	1,325	11,825	3,451	11,222	4,288	14,704
Coal (bituminous)	46,733	335,792	45,409	555,519	46,770	766,875	46,582	773,699
--- do.	NA	8	NA	8	NA	W	NA	W
Green stones	4,389	77,028	4,171	93,695	3,482	95,136	3,788	114,299
--- thousand short tons.	93,610	39,786	92,055	44,371	84,960	59,982	88,391	90,491
Natural gas	4	64	5	74	4	99	3	121
--- million cubic feet.	8,796	44,690	9,088	89,348	9,578	113,917	9,994	117,655
Peat	4,687	41,643	5,029	49,089	5,083	54,651	5,052	66,332
Petroleum (crude)	45,987	89,362	41,353	68,558	37,195	68,552	38,876	76,790
--- thousand 42-gallon barrels.	45,107	*96,009	*51,709	*105,098	46,303	108,580	42,699	106,996
Sand and gravel	XX	5,518	XX	5,680	XX	1,996	XX	1,925
--- do.	XX	806,979	XX	1,107,670	XX	1,356,454	XX	1,435,896
Value of items that cannot be disclosed: Abrasive stone, gypsum, stone (dimension, 1973-74), and values indicated by W	XX		XX		XX		XX	
--- do.	XX		XX		XX		XX	
Total	XX	806,979	XX	1,107,670	XX	1,356,454	XX	1,435,896

OKLAHOMA

Clays	1,298	*1,871	1,289	2,105	995	1,701	1,155	1,678
--- thousand short tons.	2,133	16,779	2,356	24,759	2,872	47,946	3,635	58,102
--- do.	1,429	5,796	1,235	5,622	1,028	4,835	1,120	5,822
Gypsum								
High-purity	181	6,335	169	5,915	224	7,411	243	7,686
--- million cubic feet.	115	1,380	134	1,608	148	1,776	181	2,172
Crude	1,770,950	334,110	1,638,942	458,904	1,605,410	513,731	1,726,513	866,710
--- thousand cubic feet.								
Lead (recoverable content of ores, etc.)								
Natural gas	14,674	49,070	12,581	84,638	10,835	63,333	10,894	74,416
--- thousand 42-gallon barrels.	29,044	95,264	31,231	166,461	29,640	140,197	31,620	179,602
LP gases	191,204	723,273	177,785	1,277,076	163,123	1,859,164	161,426	1,484,237
--- do.	1	1	W	W	1	W	1	W
Petroleum (crude)	5	36	W	W	W	W	W	W
--- thousand short tons.	12,154	14,941	8,708	13,772	9,691	16,749	10,037	19,050
--- do.	22,316	34,999	22,228	36,599	20,111	36,840	19,635	37,389
Sand and gravel								
--- do.								

See footnotes at end of table.

Gem stones	NA	9	NA	9	NA	9	NA	9
Lime	2,260	40,949	2,080	50,147	1,940	60,047	2,069	68,356
Mica, scrap	78,514	32,976	82,637	36,360	84,676	57,156	89,386	61,229
Natural gas	28	411	30	515	27	488	3019	36,700
Peat	3,282	18,440	3,478	36,220	3,264	39,647	19,038	55,611
Petroleum (crude)	20,576	42,830	18,071	48,181	17,401	48,742	63,607	165,889
Sand and gravel	78,564	150,346	73,092	159,615	60,177	149,870	22,280	16,487
Stone	18,887	7,792	20,288	14,567	21,090	16,450	XX	36,558
Zinc (recoverable content of ores, etc.)	XX	26,140	XX	26,993	XX	29,607	XX	XX
Value of items that cannot be disclosed: Clay (kaolin), iron ore, natural gas liquids, tripoli, and values indicated by W	XX	1,401,900	XX	2,374,428	XX	2,907,838	XX	3,041,186
Total	XX	1,401,900	XX	2,374,428	XX	2,907,838	XX	3,041,186

RHODE ISLAND

Sand and gravel	2,429	3,095	2,784	4,605	2,910	5,070	W	W
Stone	W	W	W	W	293	1,125	W	W
Value of items that cannot be disclosed: Other nonmetals and values indicated by W	XX	1,245	XX	1,377	XX	3	XX	6,400
Total	XX	4,340	XX	5,982	XX	6,198	XX	6,400

SOUTH CAROLINA

Clays	2,250	12,877	2,297	13,765	1,698	12,828	2,270	17,288
Gem stones	NA	5	NA	5	NA	5	NA	4
Mica (scrap)	W	W	W	252	7	318	W	W
Peat	14	18	18	W	18	W	15	W
Sand and gravel	8,179	12,628	7,880	18,058	7,363	14,128	7,887	17,154
Stone	14,985	24,280	12,242	42,179	13,836	30,082	13,027	30,690
Value of items that cannot be disclosed: Cement, clay (fullers earth, 1973-75), manganese ore (1975-76), stone (crushed, 1974), vermiculite, and values indicated by W	XX	38,571	XX	56,376	XX	58,107	XX	60,319
Total	XX	88,361	XX	105,171	XX	115,468	XX	125,455

SOUTH DAKOTA

Clays ^a	201	181	190	202	187	185	124	137
Gem stones	NA	42	NA	42	NA	42	NA	44
Gold (recoverable content of ores, etc.)	375,575	34,974	348,723	54,906	304,985	49,244	318,511	39,916
Gypsum	W	W	32	135	23	60	W	W

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
SOUTH DAKOTA—Continued								
Line (scrap)-----	63	\$1,206	94	\$2,059	W	W	W	W
Mica-----			W	W	W	W	W	W
Petroleum (crude)-----	975	988	494	9,293	472	\$5,998	447	\$5,519
Sand and gravel-----	13,993	16,587	9,923	9,720	6,481	8,763	5,763	8,087
Silver (recoverable content of ores, etc.)-----	72	184	62	284	68	298	58	283
Stone-----	2,745	11,607	2,968	14,231	2,647	15,850	3,241	17,240
Value of items that cannot be disclosed: Beryllium concentrates (1975-76) cement, clay (bentonite) feldspar, iron ore (1974-76), natural gas liquids (1974-76), and values indicated by W-----	XX	15,370	XX	17,938	XX	21,977	XX	30,364
Total-----	XX	81,139	XX	102,810	XX	101,821	XX	101,530
TENNESSEE								
Barite-----	W	W	W	W	13	260	W	W
Cement-----								
Masonry-----	291	7,908	154	4,706	138	4,778	175	6,476
Portland-----	1,711	42,402	1,525	43,339	1,136	37,866	1,256	43,495
Clays-----	1,719	9,063	1,633	9,776	1,310	9,008	1,630	11,578
Coal (bituminous)-----	8,219	95,857	7,641	135,874	8,206	140,233	9,233	151,372
Copper (recoverable content of ores, etc.)-----	8,690	10,115	6,304	9,745	10,041	12,893	11,131	15,494
Gold (recoverable content of ores, etc.)-----	92	7	7	7	W	W	W	W
Lime-----	20	186	186	3,448	106	8,735	W	W
Natural gas-----	20	6	6	6	6	6	47	24
millil cubic feet-----	201	W	769	7,256	682	7,842	598	8,203
thousand 42-gallon barrels-----	2,512	12,799	2,411	18,465	2,291	26,903	1,801	14,527
Phosphate rock-----	12,010	20,145	10,702	19,476	10,909	22,102	11,096	25,129
Sand and gravel-----	73	187	94	235	84	235	78	339
Silver (recoverable content of ores, etc.)-----	42,742	71,116	41,720	75,547	38,439	81,187	37,600	86,156
Stone-----	64,172	26,516	85,671	61,512	83,233	64,968	82,512	61,059
Zinc (recoverable content of ores, etc.)-----	XX	8,579	XX	6,360	XX	8,526	XX	15,862
Value of items that cannot be disclosed: Clays (selected), pyrites, and values indicated by W-----	XX	275,690	XX	395,608	XX	422,518	XX	489,714
Total-----	XX	275,690	XX	395,608	XX	422,518	XX	489,714
TEXAS								
Cement-----								
Masonry-----	234	6,606	195	6,438	181	7,089	213	10,596
Portland-----	8,320	189,368	7,739	207,706	7,195	224,504	7,368	271,066

Clays	5,697	13,115	5,915	13,677	4,248	13,411	39,706	8,847
Coal (lignite)	6,944	W	7,684	W	11,002	W	14,083	W
Gem stones	NA	163	NA	160	NA	160	NA	163
Gypsum	1,616	6,469	1,985	5,271	1,094	4,271	1,591	6,322
Helium (crude)	904	10,845	35	420	36	402	14	W
Iron ore	W	W	W	W	601	W	552	W
Lime	1,677	98,887	1,835	39,644	1,789	46,179	1,455	43,983
Natural gas	8,513,850	1,735,221	8,170,798	2,541,118	7,485,764	3,886,112	7,191,859	5,163,755
Natural gas liquids:								
natural gasoline and cycle products	92,748	347,393	88,316	629,589	78,898	479,700	77,578	560,831
LP gases	221,686	589,685	213,756	1,004,653	212,685	965,363	209,514	1,223,562
Perlite	1,294,671	5,157,623	1,262,126	8,773,003	1,291,870	9,336,570	1,189,592	10,217,702
Petroleum (crude)	1,394,871	45,309	1,379	31,298	8,560	42,119	9,718	43,875
Salt	33,946	60,106	42,466	81,864	87,649	87,106	47,848	109,217
Sand and gravel	62,574	91,379	463,074	4109,756	57,868	106,554	54,856	101,652
Stone	4,109	W	4,473	W	3,406	W	3,415	W
Sulfur (Frasch process)	232,514	1,246	186,262	1,310	123,626	795	199,668	1,071
Talc and soapstone								
Value of items that cannot be disclosed: Asphalt (native), clays (selected, 1976), fluorspar, graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1973), sodium sulfate, stone (dimension, 1974), uranium, and values indicated by W	XX	160,485	XX	245,792	XX	325,701	XX	381,413
Total	XX	8,442,494	XX	13,711,144	XX	15,855,372	XX	18,143,204

UTAH

Carbon dioxide, natural	80,490	6	93,571	6	108,941	8	21,875	2
Clays	3243	3771	232	953	320	3548	3206	381
Coal (bituminous)	5,500	61,566	5,858	71,699	6,961	138,134	7,967	182,712
Copper (recoverable content of ores, etc.)	256,589	305,341	230,593	356,497	177,155	227,467	185,458	258,157
Fluorspar	4,778	144	2,367	98	9,542	389	W	W
Gem stones	NA	95	NA	100	NA	100	NA	105
Gold (recoverable content of ores, etc.)	307,080	30,035	254,909	40,719	189,620	30,522	137,318	23,475
Gypsum	231	1,134	248	1,076	247	1,457	270	1,657
Iron ore (usable)	1,986	13,581	1,808	14,016	1,334	10,399	W	W
Lead (recoverable content of ores, etc.)	13,733	4,474	10,510	4,729	12,679	5,452	16,297	7,529
Lime	1,85	3,804	176	4,911	161	4,540	202	6,855
Natural gas	42,715	8,159	50,522	20,815	55,354	26,570	57,416	28,995
Petroleum (crude)	32,656	117,743	39,363	279,858	42,301	348,131	34,304	313,911
Pumice	42	57	15	19	23	164	264	264
Salt	717	6,913	771	7,321	631	7,717	705	10,090
Sand and gravel	15,410	15,986	11,578	12,965	10,159	14,342	510,547	13,442
Silver (recoverable content of ores, etc.)	3,619	9,257	3,208	15,109	2,822	12,472	3,194	13,633
Stone	2,848	6,318	2,969	6,410	2,486	6,167	2,751	7,009

See footnotes at end of table.

Table 6.—Mineral production in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
UTAH—Continued								
Uranium (recoverable content of U ₃ O ₈)	1,961	\$12,745	W	W	W	W	W	W
Vanadium (recoverable in ore and concentrate)	142	W	W	W	W	W	W	W
Zinc (recoverable content of ores, etc.)	16,800	6,942	12,619	\$9,060	19,640	\$15,319	22,481	\$16,636
Value of items that cannot be disclosed: Asphalt (gilsonite), beryl concentrate, cement, clays (kaolin, except 1974), magnesium chloride (1973-75), magnesium compounds, molybdenum, natural gas liquids, phosphate rock, potassium salts, sand and gravel (industrial, 1976), sodium sulfate, tungsten, and values indicated by W	XX	69,274	XX	105,664	XX	116,550	XX	153,978
Total	XX	187,4345	XX	952,045	XX	966,407	XX	1,043,981
VERMONT								
Pest	(^e)	2	(^e)	4	(^e)	W	(^e)	W
Sand and gravel	4,041	3,531	2,934	3,588	2,956	3,693	5,379	5,758
do	1,871	19,523	1,932	21,630	1,224	15,718	1,978	22,443
Stone	251,087	1,497	W	W	230,973	1,918	252,371	1,888
Talc	XX	4,763	XX	8,723	XX	7,450	XX	7,211
Value of items that cannot be disclosed: Asbestos, other nonmetals, and values indicated by W	XX	29,366	XX	33,945	XX	28,779	XX	35,097
Total	XX	29,366	XX	33,945	XX	28,779	XX	35,097
VIRGINIA								
Clays	1,646	1,886	1,987	2,614	819	1,152	862	1,210
Coal (bituminous)	33,961	377,579	34,926	856,099	35,510	1,081,587	39,396	964,669
Gem stones	NA	13	NA	NA	NA	NA	NA	NA
Lead (recoverable content of ores, etc.)	2,637	859	3,106	1,398	2,551	1,097	1,674	839
Lime	732	12,205	895	18,929	705	20,192	578	25,893
Natural gas	5,101	1,688	7,096	3,619	6,723	3,462	6,937	7,908
Petroleum (crude)	14,511	26,246	14,314	29,270	9,895	24,776	510,191	*23,089
Sand and gravel	4,600	12	W	W	W	W	W	W
Soapstone	43,395	82,719	44,176	95,983	35,384	84,204	36,132	91,723
Stone	16,683	6,894	17,195	12,346	15,151	11,818	11,214	6,519
Zinc (recoverable content of ores, etc.)	XX	35,201	XX	36,293	XX	33,673	XX	36,523
Value of items that cannot be disclosed: Aplite, cement, gypsum, kyanite, sand and gravel (industrial, 1976), silver (1975-76), and values indicated by W	XX	35,201	XX	36,293	XX	33,673	XX	36,523

	XX	545,402	XX	1,056,569	XX	1,261,974	XX	1,160,645
WASHINGTON								
Total	XX	545,402	XX	1,056,569	XX	1,261,974	XX	1,160,645
Cement	6	169	6	193	5	209	6	334
Masonry	1,194	26,651	1,377	36,347	1,147	40,666	1,298	48,669
Portland	287	664	289	698	290	778	381	1,141
Clays	3,270	21,440	3,913	W	3,743	W	4,109	W
Coal (bituminous)	NA	160	NA	160	NA	160	NA	168
Gem stones	2,217	722	1,289	585	W	W	W	W
Lead (recoverable content of ores, etc.)	21	110	14	85	13	98	14	103
Pumice	1	(6)	1	1	19,069	32,980	19,813	36,017
Sand and gravel	27,985	30,132	22,842	38,080	7,920	18,754	10,223	24,091
Stone	11,384	19,284	15,095	24,488	W	W	W	W
Zinc (recoverable content of ores, etc.)	6,378	2,635	6,909	4,960	W	W	W	W
Zinc (recoverable content of ores, etc.)	XX	12,695	XX	41,388	XX	64,850	XX	76,699
Value of items that cannot be disclosed: Clay (fire), copper, diatomite, gold, gypsum, lime, olivine, silver, talc, tungsten, uranium, and values indicated by W	XX	114,668	XX	143,980	XX	158,505	XX	187,222
Total	XX	114,668	XX	143,980	XX	158,505	XX	187,222

	XX	40,583 <th>XX</th> <th>146,201 <th>XX</th> <th>49,226 <th>XX</th> <th>66,596 </th></th></th>	XX	146,201 <th>XX</th> <th>49,226 <th>XX</th> <th>66,596 </th></th>	XX	49,226 <th>XX</th> <th>66,596 </th>	XX	66,596
WEST VIRGINIA								
Total	XX	40,583	XX	146,201	XX	49,226	XX	66,596
Clays	348	516	339	520	278	439	275	463
Coal (bituminous)	115,448	1,340,338	102,462	2,218,418	109,283	3,206,951	108,834	3,278,180
Gem stones	NA	2	NA	2	NA	2	NA	2
Natural gas	208,676	64,481	202,306	66,356	154,484	57,005	153,322	87,894
Petroleum (crude)	2,885	11,965	2,665	27,058	2,479	29,712	2,519	30,227
Salt	1,217	6,082	1,201	6,296	972	4,671	1,118	W
Sand and gravel	5,893	16,257	5,382	16,018	5,068	17,872	5,437	511,006
Stone	41,732	42,821	10,954	22,308	410,583	424,833	49,717	424,133
Value of items that cannot be disclosed: Cement (masonry and portland), clays (fire clay), lime, natural gas liquids, sand and gravel (industrial, 1976), and values indicated by W	XX	40,583	XX	146,201	XX	49,226	XX	66,596
Total	XX	1,503,045	XX	2,408,177	XX	3,390,211	XX	3,498,001

	XX	1,503,045 <th>XX</th> <th>2,408,177 <th>XX</th> <th>3,390,211 <th>XX</th> <th>3,498,001 </th></th></th>	XX	2,408,177 <th>XX</th> <th>3,390,211 <th>XX</th> <th>3,498,001 </th></th>	XX	3,390,211 <th>XX</th> <th>3,498,001 </th>	XX	3,498,001
WISCONSIN								
Total	XX	1,503,045	XX	2,408,177	XX	3,390,211	XX	3,498,001
Clays	2	3	2	4	2	4	W	W
Gem stones	NA	1	NA	1	NA	1	NA	NA
Iron ore (usable)	956	899	1,285	578	791	W	664	W
Lead (recoverable content of ores, etc.)	844	275	311	6,764	296	8,604	325	10,058
Pumice	310	6,004	311	W	11	502	11	W
Sand and gravel	40,250	43,647	28,850	34,577	30,057	40,580	30,879	42,001

See footnotes at end of table.

Table 6.—Mineral production¹ in the United States, by State—Continued

Mineral	1973		1974		1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WISCONSIN—Continued								
Stone	23,818	\$36,917	22,448	\$40,912	20,566	\$40,156	20,739	\$41,338
Zinc (recoverable content of ores, etc.)	8,672	3,583	8,737	6,273	W	W	W	W
Value of items that cannot be disclosed: Abrasive stones, cement, copper (1974-75), silver (1974-75), and values indicated by the W	XX	23,701	XX	25,654	XX	42,413	XX	39,055
Total	XX	114,389	XX	114,763	XX	132,260	XX	132,453
WYOMING								
Clays	2,343	24,043	2,511	29,339	2,582	36,046	2,697	40,015
Coal (bituminous)	14,866	60,939	20,703	103,315	23,804	160,447	30,836	215,936
Feldspar	2,588	56	NA	W	W	W	W	W
Gem stones	NA	142	NA	140	NA	140	NA	147
Gypsum	312	1,348	315	960	271	902	317	1,280
Iron ore (usable)	2,070	W	2,105	W	2,089	26,792	2,189	29,461
Lime	30	548	29	464	W	W	W	W
Natural gas	357,731	64,749	326,657	80,031	316,123	106,533	328,768	134,795
Natural gas liquids:								
LP gases	3,351	10,647	2,933	18,577	2,909	17,694	3,044	19,866
do.	7,237	22,507	6,804	31,707	6,061	29,578	6,681	35,677
Petroleum (crude)	141,914	541,820	139,987	914,360	135,943	983,785	134,149	971,235
Sand and gravel	6,201	11,635	5,582	9,508	4,328	10,746	5,470	10,782
Stone	3,191	6,716	2,384	4,989	2,882	7,618	2,757	7,630
Uranium (recoverable content of U ₃ O ₈)	10,134	65,868	7,449	78,213	6,862	84,406	8,064	129,823
Value of items that cannot be disclosed: Cement, phosphate rock, pumice (1973), sodium carbonate, and values indicated by W	XX	117,565	XX	163,997	XX	179,751	XX	254,952
Total	XX	928,583	XX	1,437,200	XX	1,644,438	XX	1,851,599

¹Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.

²Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

³Excludes certain clays, included with "Value of items that cannot be disclosed."

⁴Excludes industrial stones, included with "Value of items that cannot be disclosed."

⁵Excludes industrial sand and gravel, included with "Value of items that cannot be disclosed."

⁶Less than 1/2 unit.

⁷Total of items listed.

⁸Excludes salt in brine, included with "Value of items that cannot be disclosed."

Table 7.—Mineral production¹ in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1973		1974		1975		1976	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
American Samoa:								
Pumice -----	37	214	27	183	15	15	47	30
Stone -----	63	152	50	122	34	147	30	156
Total -----	XX	366	XX	305	XX	162	XX	186
Guam: Stone -----	1,246	3,139	798	1,444	781	1,837	457	1,438
Virgin Islands: Stone -----	664	2,860	638	3,869	253	1,813	279	2,050

XX Not applicable.

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

Table 8.—Mineral production¹ in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1973		1974		1975		1976	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement -----	2,062	41,203	1,881	70,277	1,582	60,968	1,558	66,150
Clays -----	464	473	291	332	341	440	W	W
Lime -----	42	2,215	39	2,923	28	2,231	28	2,513
Salt -----	29	580	29	624	27	639	27	639
Sand and gravel -----	7,480	21,243	NA	NA	NA	NA	NA	NA
Stone -----	15,647	41,857	14,362	41,640	13,595	47,515	13,404	47,124
Total -----	XX	107,571	XX	² 115,796	XX	² 111,793	XX	² 116,426

NA Not available. W Withheld to avoid disclosing individual company confidential data. XX Not applicable.

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

²Total does not include value of items withheld or not available.

Table 9.—U.S. exports of principal minerals and products

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS				
Aluminum:				
Ingot, slabs, crude	short tons	185,850		\$134,064
Scrap	do.	66,937		29,169
Plates, sheets, bars, etc.	do.	171,008		228,684
Castings and forgings	do.	5,008		18,813
Aluminum sulfate	do.	47,688		2,897
Other aluminum compounds	do.	835,920		131,726
Antimony, metals and alloys, crude	do.	339		348
Bauxite, including bauxite concentrates	thousand long tons	19		1,651
	pounds	37,336		1,152
Bismuth, metals and alloys	do.	128,893		4,636
Cadmium	thousand pounds	396		589
Calcium:				
Carbonate	short tons	4,640		705
Chloride	do.	28,359		2,314
Dicalcium phosphate	do.	21,053		6,270
Chrome:				
Ore and concentrates:				
Exports	thousand short tons	139		6,896
Reexports	do.	45		2,111
Ferrocchrome	do.	13		9,075
Cobalt	thousand pounds	4,287		14,881
Columbium metals, alloys, other forms	do.	53		787
Copper:				
Ore, concentrate, composition metal, and unrefined (copper content)	short tons	16,451		14,454
Scrap	do.	45,002		40,793
Refined copper and semimanufactures	do.	258,165		465,553
Other copper manufactures	do.	9,518		14,158
Copper sulfate or blue vitriol	do.	1,248		2,067
Copper-base alloys	do.	130,254		179,838
Ferroalloys:				
Ferrosilicon	do.	39,712		15,732
Ferrophosphorus	do.	437		57
Gold:				
Ore and base bullion	troy ounces	393,970		63,654
Bullion, refined	do.	3,101,812		429,278
Iron ore	thousand long tons	2,537		60,071
Iron and steel:				
Pig iron	short tons	59,596		4,636
Iron and steel products (major):				
Semimanufactures	do.	1,690,956		633,502
Manufactures and steel mill products	do.	2,284,043		2,336,341
Iron and steel scrap: Ferrous scrap, including rerolling materials	thousand short tons	9,642		780,984
Slag	short tons	139,516		5,506
Lead:				
Pigs, bars, anodes, sheets, etc.	short tons	21,256		12,041
Scrap	do.	49,951		10,063
Magnesium, metal and alloys, scrap, semi-manufactured forms, n.e.c.				
	do.	32,591		48,191
Manganese:				
Ore and concentrate	do.	204,523		13,886
Ferromanganese	do.	32,487		10,743
Metal	do.	3,256		3,318
Mercury:				
Exports	76-pound flasks	339		152
Reexports	do.	155		68
Molybdenum:				
Ore and concentrates (molybdenum content)	thousand pounds	62,611		159,592
Metals and alloys, crude and scrap	do.	317		858
Wire	do.	270		2,863
Semimanufactured forms, n.e.c.	do.	312		1,790
Powder	do.	60		296
Ferromolybdenum	do.	2,241		4,798
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc.	short tons	23,118		102,400
Catalysts	do.	3,536		13,713
Nickel-chrome electric resistance wire	do.	679		4,769
Semifabricated forms, n.e.c.	do.	2,788		20,420
Platinum:				
Ore, concentrate, metal and alloys in ingots, bars, sheets, anodes, other forms, including scrap	troy ounces	376,450		56,412
Palladium, rhodium, iridium, osmium, ruthenium, and osmium (metal and alloys including scrap)	do.	283,435		31,102

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products—Continued

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued				
Platinum—Continued				
Platinum-group manufactures, except jewelry	NA	\$3,246	NA	\$2,977
Rare earths:				
Cerium ore, metal, alloys				
lighter flints ----- pounds	100,279	300	119,792	335
Silicon:				
Ferrosilicon ----- short tons	\$39,712	\$15,732	12,416	7,449
Silicon carbide, crude and in grains ----- do.	12,970	6,839	10,106	6,174
Silver:				
Ore, concentrates, waste, sweepings				
thousand troy ounces -----	10,005	43,481	7,000	28,849
Bullion, refined ----- do.	22,621	104,086	7,596	32,586
Tantalum:				
Ore, metal, other forms ----- thousand pounds	531	5,545	213	6,711
Powder ----- do.	161	5,974	110	7,982
Tin:				
Ingots, pigs, bars, etc.:				
Exports ----- metric tons	\$1,444	10,457	540	2,998
Reexports ----- do.	\$2,152	15,531	1,798	13,967
Tin scrap and other tin-bearing material except tinplate scrap ----- do.	5,062	4,343	6,927	7,391
Titanium:				
Ore and concentrate ----- short tons	3,147	505	4,802	477
Sponge (including iodide titanium and scrap) ----- do.	4,326	7,630	6,144	8,547
Intermediate mill shapes and mill products, n.e.c. ----- do.	1,900	24,726	1,065	15,039
Dioxide and pigments ----- do.	15,807	12,110	20,580	16,229
Tungsten, ore and concentrates:				
Exports ----- thousand pounds	1,316	8,082	1,729	11,189
Reexports ----- do.	316	930	887	1,903
Uranium:				
Ores and concentrates (U ₃ O ₈ content) ----- pounds	122,663	1,840	1,495,130	24,432
Metal ----- do.	14,840	203	7,108	146
Compounds ----- do.	3,837,266	52,040	369,036	7,232
Isotopes (stable) and their compounds ----- do.	NA	2,679	NA	2,103
Radioactive materials ----- thousand curies	37,850,386	20,088	31,474,488	25,905
Special nuclear materials ----- do.	NA	236,849	NA	426,423
Vanadium:				
Ore and concentrate, pentoxide, etc. (vanadium content) ----- pounds	430,592	1,628	197,035	742
Ferrovanadium ----- do.	2,035,851	7,952	2,421,776	9,180
Zinc:				
Slabs, pigs, or blocks ----- short tons	6,897	5,870	3,513	2,306
Sheets, plates, strips, other forms n.e.c. ----- do.	1,629	2,086	2,271	2,817
Waste, scrap, and dust (zinc content) ----- do.	5,051	2,448	8,945	3,535
Semifabricated forms, n.e.c. ----- do.	14,196	9,379	9,320	6,076
Zirconium:				
Ore and concentrate ----- pounds	37,531,345	4,787	18,855,595	2,784
Metals, alloys, other forms ----- do.	2,649,694	\$25,828	2,304,202	43,809
NONMETALS				
Abrasives:				
Dust and powder of precious or semiprecious stones, including diamond dust and powder ----- thousand carats	12,802	32,088	14,155	35,450
Crushing bort ----- do.	3	12	77	182
Industrial diamonds ----- do.	950	5,948	639	3,677
Diamond grinding wheels ----- do.	684	4,933	730	4,911
Other natural and artificial metallic abrasives and products ----- do.	NA	59,868	NA	63,979
Asbestos:				
Exports:				
Unmanufactured ----- short tons	34,921	10,059	46,317	12,640
Products ----- do.	NA	60,556	NA	60,276
Reexports:				
Unmanufactured ----- do.	1,526	608	606	151
Products ----- do.	NA	220	NA	296
Barite:				
Natural barium sulfate ----- do.	57,386	1,868	41,063	2,871
Lithopone ----- do.	1,833	1,060	779	937
Boron:				
Boric acid ----- do.	33,697	11,532	36,492	12,363
Sodium borates, refined ----- do.	212,266	42,486	211,362	49,156
Cement ----- do.	494,132	28,409	466,055	26,601
Clays:				
Kaolin or china clay ----- do.	878,619	47,905	839,230	57,649
Fire clay ----- do.	219,431	7,191	296,016	12,895

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products—Continued

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS—Continued				
Clays—Continued				
Other clays	short tons	1,216,088	1,351,953	\$81,409
Feldspar, leucite nepheline syenite	thousand pounds	19,087	12,289	352
Fluorspar	short tons	1,355	4,923	764
Gem stones:				
Diamonds	thousand carats	265	313	306,098
Pearls		NA	NA	581
Other		NA	NA	30,896
Graphite	short tons	10,586	79,098	6,753
Gypsum:				
Crude, crushed or calcined	thousand short tons	75	284	6,739
Manufactures, n.e.c.		NA	NA	25,855
Lithium hydroxide	thousand pounds	1,226	534	674
Kyanite and allied minerals	short tons	150,369	63,329	4,942
Lime	do.	53,853	55,852	2,981
Magnesium compounds:				
Magnesite, dead-burned	thousand pounds	165,309	142,745	13,466
Magnesite, crude, caustic calcined, lump or ground	do.	18,195	20,242	5,422
Mica sheet, waste and scrap, and ground	pounds	10,977,353	14,449,150	3,477
Mica, manufactured	do.	1,132,301	2,481,151	3,776
Mineral-earth pigments, iron oxide, natural and manufactured				
	short tons	13,231	11,867	11,387
Nitrogen compounds (major)	thousand short tons	4,736	4,714	449,147
Phosphate rock	do.	12,606	461,553	327,410
Phosphatic fertilizers:				
Superphosphates	do.	1,166	1,334	110,835
Ammonium phosphates	do.	2,422	2,406	269,855
Elemental phosphorus	short tons	35,845	29,038	30,387
Mixed chemical fertilizers	thousand short tons	324	42	30,284
Pigments and compounds (lead and zinc):				
Lead oxides:				
Pigment grade	short tons	1,695	2,620	1,661
Other grade	do.	580	345	498
Zinc oxides:				
Pigment grade	do.	2,389	4,261	2,587
Other grade	do.	715	577	524
Zinc compounds	do.	917	779	937
Potash:				
Fertilizer	do.	1,419,317	1,669,691	91,887
Chemical	do.	104,497	60,025	19,422
Pumice and pumicite	thousand pounds	2,504	2,022	271
Quartz, natural, quartzite, cryolite, chiolite	short tons	1,767	—	—
Salt:				
Crude and refined	thousand short tons	1,332	1,007	10,326
Shipments to noncontiguous territories	do.	20	18	2,230
Sand and gravel:				
Sand:				
Construction	short tons	510,859	558,733	1,337
Industrial	do.	2,171,109	2,553,475	17,080
Gravel	do.	537,290	579,359	1,099
Sodium and sodium compounds:				
Sodium sulfate	do.	77	57	3,636
Sodium carbonate	do.	529	645	49,781
Stone:				
Dolomite, block	do.	49	63	1,486
Limestone, crushed, ground, broken	do.	3,386	3,191	10,537
Marble and other building and monumental	do.	NA	NA	2,596
Stone, crushed, ground, broken	thousand short tons	896	866	7,073
Manufactures of stone	do.	NA	NA	2,273
Sulfur:				
Crude	thousand long tons	1,288	1,183	60,226
Crushed, ground flowers of	do.	7	15	3,358
Talc, crude and ground	short tons	157,681	212,344	9,034
MINERAL FUELS				
Carbon black	thousand pounds	87,947	110,760	27,231
Coal:				
Anthracite	thousand short tons	640	615	24,008
Bituminous	do.	65,669	59,406	2,886,467
Briquets	do.	90	87	10,998
Coke	do.	1,273	1,315	66,726
Natural gas	thousand cubic feet	105,879,552	95,866,953	140,854
Petroleum:				
Crude	thousand barrels	19	2,227	27,129
Gasoline	do.	185	266	5,592
Jet fuel	do.	326	348	3,404
Naphtha	do.	1,168	2,608	37,045
Kerosine	do.	28	33	504
Distillate oil	do.	92	97	1,333

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products —Continued

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
MINERAL FUELS —Continued				
Petroleum —Continued				
Residual oil ----- thousand barrels	4,892	\$43,179	3,438	\$32,301
Lubricating oil ----- do	8,827	300,873	6,749	206,681
Asphalt ----- do	245	6,222	262	8,051
Liquefied petroleum gases ----- do	9,432	100,041	8,967	98,981
Wax ----- do	581	27,502	605	30,997
Coke ----- do	36,949	315,239	33,315	352,523
Petrochemical feedstocks ----- do	7,436	95,681	6,885	91,491
Miscellaneous ----- do	1,088	43,976	1,016	46,366
Total -----	XX	¹14,345,654	XX	12,514,499

¹Revised. NA Not available.
²Adjusted by the Bureau of Mines.

Table 10.—U.S. imports for consumption of principal minerals and products

Mineral	1975		1976		
	Quantity	Value (thousands)	Quantity	Value (thousands)	
METALS					
Aluminum:					
Metal	short tons	434,119	\$316,873	575,350	\$439,570
Scrap	do.	54,806	27,586	85,714	46,166
Plates, sheets, bars, etc.	do.	61,354	65,079	87,560	96,312
Aluminum oxide (alumina)	do.	3,507,415	370,039	3,624,367	404,478
Antimony:					
Ore (antimony content)	do.	8,320	14,535	10,023	16,911
Needle or liquated	do.	74	255	41	129
Metal	do.	2,112	5,677	2,083	4,986
Oxide	do.	9,908	12,588	11,611	17,029
Arsenic:					
White (As ₂ O ₃ content)	do.	12,013	4,426	4,262	1,598
Metallic	do.	483	2,716	288	1,735
Bauxite, crude	thousand long tons	11,529	NA	12,548	NA
Beryllium ore	short tons	1,479	1,468	1,058	380
Bismuth	pounds	1,331,173	9,442	2,328,051	14,154
Cadmium:					
Metal	short tons	2,618	13,902	3,411	14,511
Flue dust (cadmium content)	do.	346	1,489	246	536
Calcium:					
Metal	pounds	70,128	78	461,965	475
Chloride	short tons	12,021	598	16,046	480
Chrome:					
Ore and concentrates (Cr ₂ O ₃ content)	thousand short tons	559	60,651	533	70,075
Ferrocchrome	do.	198	190,630	150	124,819
Metal	do.	2	6,630	2	9,142
Cobalt:					
Metal	thousand pounds	6,092	25,611	15,129	66,299
Oxide (gross weight)	do.	233	779	138	573
Salts and compounds (gross weight)	do.	41	74	235	365
Columbium ore	do.	1,542	2,012	3,968	5,737
Copper (copper content):					
Ore and concentrates	short tons	29,301	35,649	35,197	49,861
Regulus, black, coarse	do.	5,675	20,560	14,097	54,878
Unrefined, black, blister	do.	78,969	90,846	19,388	22,144
Refined in ingots, etc.	do.	142,945	166,159	381,343	453,279
Old and scrap	do.	14,399	14,459	19,735	19,231
Ferroalloys, n.e.c.	do.	1,946	15,556	99,905	47,430
Gallium	kilograms	6,830	3,555	4,920	2,326
Gold (general imports):					
Ore and base bullion	troy ounces	313,038	50,055	166,312	20,007
Bullion	do.	2,348,936	406,583	2,489,679	311,011
Indium	do.	113,800	629	290,139	1,802
Iron ore	thousand long tons	46,743	860,496	44,390	980,348
Iron and steel:					
Pig iron	short tons	478,106	69,316	444,282	51,142
Iron and steel products (major):					
Iron products	do.	47,535	32,299	44,877	32,002
Steel products	do.	12,440,326	4,475,191	13,051,471	4,479,191
Scrap	do.	293,082	24,464	495,584	34,524
Tinplate	do.	12,277	786	11,581	596
Lead:					
Ore, flue dust, matte (lead content)	do.	45,024	12,329	88,988	29,492
Base bullion (lead content)	do.	462	183	2,334	955
Pigs and bars (lead content)	do.	99,054	46,703	141,980	60,245
Reclaimed scrap, etc. (lead content)	do.	1,741	617	2,644	1,022
Sheet, pipe, shot	do.	147	99	294	495
Magnesium:					
Metallic and scrap	do.	6,787	9,299	13,066	19,020
Alloys (magnesium content)	do.	1,111	2,215	1,820	3,604
Sheets, tubing, ribbons, wire, other forms (magnesium content)	do.	5	33	21	38
Manganese:					
Ore (35% or more contained manganese)	do.	765,530	77,103	649,245	73,627
Ferromanganese (manganese content)	do.	306,650	128,381	417,433	164,698
Metal	do.	4,378	4,041	7,082	5,258
Mercury:					
Compounds	pounds	16,112	142	35,536	90
Metal	76-pound flasks	43,865	7,599	44,415	4,325
Minor metals: Selenium and salts	pounds	889,320	10,265	811,257	12,118
Molybdenum:					
Ore (content)	do.	2,556,680	5,916	2,092,623	4,850
Waste and scrap	do.	44,672	101	297,554	1,183
Metal	do.	38,926	434	63,500	705,274
Compounds	do.	682,039	745	679,289	690
Nickel:					
Pigs, ingots, shot, cathodes	short tons	107,084	406,894	111,255	456,398
Plates, bars, etc.	do.	1,752	11,118	3,223	20,348
Slurry	do.	23,991	63,522	33,280	98,178
Scrap	do.	2,353	5,864	2,859	4,827
Powder and flakes	do.	9,772	39,413	10,181	45,267
Ferronickel	do.	65,046	67,818	55,721	72,161
Oxide	do.	5,063	15,172	5,932	21,948

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products —Continued

Mineral	1975		1976		
	Quantity	Value (thousands)	Quantity	Value (thousands)	
METALS—Continued					
Platinum-group metals:					
Unwrought:					
Grains and nuggets (platinum)	troy ounces	19,253	\$2,941	596	\$88
Sponge (platinum)	do	567,466	91,567	904,048	139,378
Sweepings, waste, scrap	do	116,523	14,278	146,773	20,080
Iridium	do	14,419	6,892	18,179	5,045
Palladium	do	409,862	33,863	994,360	48,535
Rhodium	do	80,197	34,400	62,260	18,342
Ruthenium	do	16,535	926	75,673	3,580
Other platinum-group metals	do	234,757	37,055	224,560	32,195
Semimanufactured:					
Platinum	do	96,630	15,337	95,653	15,623
Palladium	do	144,240	15,163	128,951	6,325
Rhodium	do	1,832	675	1,864	382
Other platinum-group metals	do	118,570	19,726	14,142	1,963
Radium: Radioactive substitutes		NA	8,297	NA	12,200
Rare-earth metals, ferrocerium, other cerium alloys					
	pounds	33,852	187	40,259	167
Silicon (silicon content):					
Metal	short tons	3,852	6,591	2,1359	26,170
Ferrosilicon	do	47,365	41,950	64,124	39,808
Silver (general imports):					
Ore and base bullion	thousand troy ounces	21,197	87,755	16,717	70,206
Bullion	do	61,629	274,254	67,187	289,032
Sweepings, waste, dore	do	7,596	32,527	4,454	18,823
Tantalum ore	thousand pounds	1,753	7,794	2,557	15,124
Tin:					
Ore (tin content)	metric tons	6,415	44,114	5,733	38,529
Blocks, pigs, grains, etc	do	44,366	312,346	45,955	325,453
Dross, skimmings, scrap, residue, and tin alloys, n.s.p.f	do	2,468	2,452	2,666	3,550
Tin foil, powder, flitters, etc	do	NA	7,257	NA	8,148
Titanium:					
Ilmenite ^a	short tons	334,692	15,903	431,717	18,715
Rutile	do	224,499	46,362	281,712	54,849
Metal	pounds	10,549,619	18,332	7,922,050	12,690
Ferrotitanium	do	1,071,048	1,125	1,798,936	1,438
Compounds and mixtures	do	53,964,945	19,654	140,795,246	53,806
Tungsten (tungsten content):					
Ore and concentrate	thousand pounds	6,570	31,665	5,301	28,320
Waste and scrap	do	71	317	170	694
Other alloys	do	1,898	11,104	2,473	14,255
Ferrotungsten	do	418	2,542	844	5,451
Uranium and other uranium-bearing and nuclear materials:					
Oxide U ₃ O ₈	do	2,451,538	24,481	11,074,298	209,926
Compounds, n.e.c	do	19,226,578	161,507	33,876,908	441,603
Isotopes (stable) and their compounds	do	NA	957	NA	1,067
Radio isotopes, elements, etc	thousand curies	35,346,036	8,297	60,302,966	12,200
Vanadium (content):					
Ferrovandium	thousand pounds	273	1,435	518	2,448
Vanadium-bearing materials (vanadium pentoxide content)	do	8,185	7,075	10,702	7,721
Zinc:					
Ore (zinc content)	short tons	428,544	108,822	155,803	50,553
Blocks, pigs, slabs	do	374,922	273,636	695,131	482,265
Sheets, etc	do	736	507	209	329
Old, dross, skimmings	do	3,158	1,238	12,445	4,884
Dust, powder, flakes	do	5,739	5,744	6,009	5,134
Manufactures	do	NA	79	NA	96
Zirconium:					
Ore, including zirconium sand	short tons	40,205	8,874	64,643	13,733
Unwrought, scrap, and compounds	do	2,013	5,991	914	1,153
NONMETALS					
Abrasives:					
Diamonds (industrial)	thousand carats	14,291	53,383	17,047	61,102
Other abrasives	do	NA	68,480	NA	96,130
Asbestos	short tons	538,553	111,011	657,851	142,145
Barite:					
Crude and ground	do	672,528	9,264	917,812	17,829
Witherite	do	85	44	278	56
Chemicals	do	10,937	4,443	16,913	5,095
Boron:					
Carbide	pounds	137,572	645	30,232	240
Boric acid	do	345,237	759	112,870	14
Calcium borate, crude	do	55,282,329	1,560	60,493,065	1,953
Cement	thousand short tons	3,702	70,620	3,107	67,085
Clays:					
Raw	short tons	33,851	1,644	34,359	1,207
Manufactured	do	4,143	308	4,309	607
Cryolite	do	22,120	9,058	11,325	4,329

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products—Continued

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS—Continued				
Feldspar:				
Crude..... short tons.....	1,209	\$17	93	\$17,614
Ground and crushed..... do.....	81	6		
Fluorspar..... do.....	1,050,448	61,059	895,254	56,580
Gem stones:				
Diamond..... thousand carats.....	4,577	722,119	6,716	1,011,839
Emeralds..... do.....	806	40,348	1,165	55,286
Other..... NA.....		87,963	NA	112,241
Graphite..... short tons.....	65,663	5,698	79,098	6,753
Gypsum:				
Crude, ground, calcined..... thousand short tons.....	5,450	16,193	6,253	18,285
Manufactures..... NA.....		3,617	NA	3,468
Iodine, crude..... thousand pounds.....	5,309	11,721	6,482	13,824
Kyanite..... short tons.....	65	3	110	12
Lime:				
Hydrated..... do.....	44,637	1,392	48,461	1,814
Other..... do.....	214,311	4,867	316,442	8,816
Lithium:				
Ore..... do.....	4,548	538	68	1
Compounds..... do.....	11	107	48	621
Magnesium compounds:				
Crude magnesite..... do.....	10	1	18	2
Lump, ground, caustic-calcined magnesia..... do.....	5,716	502	8,194	808
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite..... do.....	156,332	24,668	88,035	14,518
Compounds..... do.....	36,572	1,796	27,039	2,267
Mica:				
Uncut sheet and punch..... thousand pounds.....	904	696	1,654	941
Scrap..... do.....	10,672	356	4,210	202
Manufactures..... do.....	5,075	2,935	3,328	3,193
Mineral-earth pigments, iron oxide pigments:				
Ocher, crude and refined..... short tons.....	20	3	50	11
Siennas, crude and refined..... do.....	521	107	624	122
Umber, crude and refined..... do.....	4,251	350	6,908	561
Vandyke brown..... do.....	319	57	739	147
Natural, other..... do.....	1,001	223	1,231	190
Synthetic..... do.....	21,867	8,444	40,547	15,523
Nepheline syenite:				
Crude..... do.....	6,275	98	2,112	38
Ground, crushed, etc..... do.....	424,838	6,869	499,135	8,785
Nitrogen compounds (major), including urea..... thousand short tons.....	3,113	415,534	3,467	296,814
Phosphate, crude..... do.....	37	1,604	51	2,234
Phosphatic fertilizers..... do.....	147	26,970	47	6,631
Pigments and salts:				
Lead pigments and compounds..... short tons.....	15,337	7,470	17,836	9,462
Zinc pigments and compounds..... do.....	18,447	10,746	27,969	15,557
Potash..... do.....	6,292,329	285,272	7,595,246	360,756
Pumice:				
Crude or unmanufactured..... do.....	3,260	77	3,344	148
Wholly or partly manufactured..... do.....	142,120	380	78,057	350
Manufactures, n.s.p.f..... NA.....		76	NA	70
Quartz crystal (Brazilian pebble)..... pounds.....	1,487,272	931	1,148,801	368
Salt..... thousand short tons.....	3,215	15,272	4,352	23,476
Sand and gravel:				
Glass sand..... do.....	45	475	61	484
Other sand and gravel..... do.....	329	301	292	425
Sodium sulfate..... do.....	285	12,624	316	16,111
Stone and whiting..... NA.....		46,137	NA	46,211
Strontium:				
Mineral..... short tons.....	21,613	826	35,711	1,486
Compounds..... do.....	3,100	1,261	5,370	2,334
Sulfur and compounds, sulfur ore and other forms, n.e.s. thousand long tons.....	1,897	70,843	1,727	59,494
Talc, unmanufactured..... short tons.....	23,378	1,471	20,071	1,861
MINERAL FUELS				
Carbon black:				
Acetylene..... pounds.....	5,839,266	2,578	8,294,902	4,366
Gas black and carbon black..... do.....	33,034,187	4,284	44,120,742	7,016
Coal:				
Bituminous, slack, culm, lignite..... short tons.....	939,721	21,682	1,203,076	17,739
Briquets..... do.....	16,367	270	18,829	434
Coke..... do.....	1,818,931	156,488	1,311,472	111,066
Natural gas, ethane, methane, and mixtures thereof..... thousand cubic feet.....	944,352,390	1,070,539	943,432,188	1,611,644
Peat:				
Fertilizer grade..... short tons.....	283,732	23,371	332,433	28,939
Poultry and stable grade..... do.....	6,626	488	5,618	553
Petroleum:				
Crude petroleum..... thousand barrels.....	1,581,129	18,290,012	2,051,307	25,456,155
Distillate..... do.....	39,420	489,351	22,023	270,707

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products —Continued

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
MINERAL FUELS—Continued				
Petroleum —Continued				
Residual ----- thousand barrels	362,084	\$3,958,178	405,833	\$4,372,317
Unfinished oils ----- do	1,514	18,042	5,686	74,934
Gasoline ----- do	22,740	314,971	8,073	130,373
Jet fuel ----- do	44,368	619,102	26,056	373,450
Motor fuels, n.e.s. ----- do	666	8,799	1,019	12,178
Kerosine ----- do	46	511	(¹)	2
Lubricants ----- do	190	4,159	547	5,491
Wax ----- do	157	6,128	164	5,212
Naphtha ----- do	64,654	782,485	51,112	702,583
Liquefied petroleum gases ----- do	41,171	354,947	47,528	396,035
Asphalt ----- do	4,835	52,274	4,388	46,022
Miscellaneous ----- do	21,285	248,453	18,372	256,230
Total -----	XX	² 38,847,295	XX	48,718,321

¹Revised. NA Not available. XX Not applicable.

²Adjusted by the Bureau of Mines.

³Does not include silicon metal more than 96% but less than 99% silicon.

⁴Includes titanium slag averaging about 70% TiO₂ for detail see Titanium chapter.

⁵Less than 1/2 unit.

Table 11.—Comparison of world and U. S. production of principal mineral commodities
(Thousand short tons unless otherwise specified)

Minerals	1976*			
	World production ¹	U. S. production	U. S. percent of world production	U. S. percent of world production
MINERAL FUELS				
Carbon black	6,987	2,742	40	39
Coal	21,976,155	698,619	32	32
Bituminous	9,444,777	19,819	2	3
Lignite	196,301	6,208	3	3
Pennsylvania anthracite	18,816	57,207	17	14
Gashouse ³	400,470	40,713	10	14
Oven and beehive	47,517,774	20,108,661	42	40
Natural gas (marketable)	223,980	222,856	(*)	(*)
Peat	19,437,604	3,052,048	16	14
Petroleum (crude)	4,564	99	2	2
Asbestos	5,358	1,318	25	25
Barite	774,277	59,721	9	9
Cement	15,969	65,384	33	36
Clay, china	9	—	—	—
Corundum	41,108	—	—	—
Diamond	1,880	573	31	33
Diatomite	2,893	670	23	26
Feldspar	5,015	140	3	4
Fluorspar	486	W	NA	NA
Graphite	62,855	9,751	16	13
Gypsum	113,687	51,161	17	17
Lime (sold or used)	11,147	W	W	W
Magnesite	489,464	270,005	54	NA
Mica (including scrap)	46,722	59,341	20	51
Nitrogen, agricultural ⁷	118,254	48,316	41	42
Phosphate rock	27,352	2,501	9	9
Potash (K ₂ O equivalent)	22,097	3,907	23	24
Pumice ⁸	178,432	51,057	28	24
Pyrites	58	—	—	—
Salt	49,877	11,959	23	22
Strontium ⁸	5,385	1,092	18	16
Sulfur elemental	5,879	330	57	54
Talc, pyrophyllite, soapstone	—	—	—	—
Vermiculite ⁸	—	—	—	—

METALS, MINE BASIS

Antimony (content of ore and concentrate)	76,286	886	1	76,286	283	(*)
Arsenic, white	46,449	W	NA	39,919	W	NA
Bauxite	74,508	91,772	2	76,337	91,958	3
Beryl	3,608	W	NA	9,035	W	NA
Bismuth	8,918	W	NA	9,932	W	NA
Chromite	9,071	W	NA	9,492	W	NA
Cobalt (contained)	32,452	--	--	28,681	--	--
Columbium-tantalum concentrate [§]	33,354	--	--	50,845	--	--
Copper (content of ore and concentrate)	7,672	10,143	18	8,213	101,606	20
Iron ore	38,676	1,052	3	39,883	1,048	3
Lead (content of ore and concentrate)	887,389	1,78,866	9	881,028	1,79,998	9
Manganese ore (35% or more Mn)	3,750	621	17	3,701	610	16
Mercury	27,076	--	--	27,292	--	--
Molybdenum (content of ore and concentrate)	252	7	3	244	23	9
Nickel (content of ore and concentrate)	176,713	105,980	60	191,287	113,233	59
Radium-group metals	868	17	2	886	16	2
Silver	5,714	19	(*)	5,992	6	(*)
Tin (content of ore and concentrate)	297,862	34,988	12	304,899	34,828	11
Titanium concentrates:	224,180	W	NA	225,755	W	NA
Ilmenite	3,218	717	22	3,512	652	19
Rutile [§]	417	W	NA	471	W	NA
Tungsten concentrate (contained tungsten)	84,262	5,588	7	91,845	5,880	6
Uranium oxide (U ₃ O ₈) [§]	26,677	11,600	43	30,100	12,700	42
Vanadium (content of ore and concentrate)	23,201	4,743	20	25,950	7,376	8
Zinc (content of ore and concentrate)	6,391	469	7	6,462	485	8

See footnotes at end of table.

Table 11.—Comparison of world and U. S. production of principal mineral commodities —Continued
(Thousand short tons unless otherwise specified)

Minerals	1975				1976 ²			
	World production ¹	U.S. production	U.S. percent of world production	World production ¹	U.S. production	U.S. percent of world production	World production ¹	U.S. percent of world production
METALS, SMELTER BASIS								
Aluminum	13,352	3,879	29	13,774	4,251	31	13,774	31
Cadmium	16,925	12,193	13	18,892	12,256	12	18,892	12
Copper	7,793	11,447	19	8,164	11,535	19	8,164	19
Iron, pig	528,861	79,721	15	549,298	86,848	16	549,298	16
Lead	3,656	1,636	17	3,788	1,653	17	3,788	17
Magnesium	188	W	NA	148	W	NA	148	NA
Selenium ³	2,561	358	14	2,773	401	14	2,773	14
Steel ingots and castings	712,556	1 ¹ 116,642	16	748,492	1 ¹ 123,000	17	748,492	17
Tellurium ⁴	315	131	42	NA	W	NA	NA	NA
Tin	280,596	1 ⁶ 6,500	3	228,856	1 ⁶ 5,700	2	228,856	2
Zinc	5,592	438	8	5,978	499	8	5,978	8

¹Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data.

²May not represent total world production because confidential U.S. data are excluded for some commodities. World totals include reported figures and reasonable estimates; however, for some commodities where data were not available, no reasonable estimates could be made and none have been included.

³Includes small quantities of lignite for People's Republic of China and Pakistan, and anthracite for Colombia.

⁴Includes low- and medium-temperature and gas-house coke.

⁵Less than 1/2 unit.

⁶Includes Puerto Rico.

⁷Kaolin sold or used by producers.

⁸Year ended June 30 of year stated (United Nations).

⁹World total exclusive of the U.S.S.R.

¹⁰Dry bauxite, equivalent of crude ore.

¹¹Recoverable.

¹²Includes byproduct ore.

¹³Includes secondary.

¹⁴Smelter output from domestic and foreign ores, exclusive of scrap.

¹⁵Lead refined from domestic and foreign ores; excludes lead refined from imported base bullion.

¹⁶Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingot.

¹⁷Includes tin content of alloys made directly from ore.

The Mineral Industry of Alabama

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

By James R. Boyle¹ and T. L. Neathery²

The value of mineral production increased 6.2% in 1976. With the exception of coal, practically all commodities registered an increase in production and value; most had an increase in unit value. Total value exceeded \$1 billion for the first time. The increase in nearly all nonmetallic mineral production was a complete reversal of the 1975 experience. Alabama led the Nation in the production of crushed marble and was second in bauxite and scrap mica, third in oystershell, third in kaolin, and fifth in dimension limestone and dimension marble.

International Trade.—The international trade passing through the Mobile customs

district was valued at \$2,524 million in fiscal year 1976, up 20% from that of the previous year. Of the total value of trade passing through the district, 52% of the value of exports and 89% of the value of imports were handled through the port at Mobile. The major export commodity was coal through McDuffie Coal Terminal which amounted to nearly 2.9 million tons, up from 2.4 million tons in 1975. Coal exports were to Japan, Italy, Turkey, the United Kingdom, and Brazil. Other exports were cement (114,000 tons) and

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Table 1.—Mineral production in Alabama¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ----- thousand short tons--	262	\$10,253	314	\$13,671
Portland ----- do-----	1,968	62,599	2,134	70,365
Clays ² ----- do-----	2,231	9,077	2,239	10,325
Coal (bituminous) ----- do-----	22,644	600,767	21,537	611,069
Lime ----- do-----	985	29,404	1,009	32,753
Natural gas ----- million cubic feet--	37,814	32,898	41,427	40,806
Petroleum (crude) ----- thousand 42-gallon barrels--	13,477	136,541	14,706	155,437
Sand and gravel ----- thousand short tons--	9,232	17,376	12,023	20,933
Stone ----- do-----	22,252	61,515	23,832	65,429
Value of items that cannot be disclosed: Asphalt (native), bauxite, clay (bentonite), iron ore (1975), mica, natural gas liquids, salt, and talc (1975) ---	XX	8,543	XX	8,748
Total -----	XX	968,973	XX	1,029,536
Total 1967 constant dollars -----	XX	383,423	XX	P 370,118

^P Preliminary. XX Not applicable.

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

² Excludes bentonite; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Alabama, by county^{1 2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Autauga	W	W	Sand and gravel.
Baldwin	W	W	Sand and gravel, clays.
Barbour	W	W	Clays, bauxite, sand and gravel.
Bibb	W	W	Coal, stone, clays.
Blount	\$20,055	W	Coal, sand and gravel, cement, stone.
Calhoun	3,099	W	Stone, clays, sand and gravel.
Cherokee	217	\$2,609	Coal, sand and gravel.
Chilton	W	W	Sand and gravel, clays.
Choctaw	34,929	43,376	Petroleum, natural gas, natural gas liquids.
Clarke	W	W	Sand and gravel.
Clay	—	3	Do.
Coffee	71	89	Do.
Colbert	W	W	Stone, native asphalt, sand and gravel.
Conecuh	766	W	Petroleum, natural gas, sand and gravel.
Crenshaw	31	20	Sand and gravel.
Cullman	13,891	17,655	Coal.
Dale	W	W	Sand and gravel.
Dallas	W	W	Sand and gravel, clays.
De Kalb	W	W	Coal, stone.
Elmore	W	W	Sand and gravel, clays.
Escambia	74,057	75,075	Petroleum, natural gas, sand and gravel, clays.
Etowah	W	W	Stone, coal, sand and gravel.
Fayette	W	W	Coal, natural gas, sand and gravel.
Franklin	W	W	Coal, stone, sand and gravel.
Geneva	W	8	Sand and gravel.
Hale	17	7	Do.
Henry	W	W	Clays, bauxite, stone.
Houston	W	W	Sand and gravel.
Jackson	W	W	Coal, stone.
Jefferson	W	W	Coal, cement, stone, clays, sand and gravel.
Lamar	1,304	5,365	Coal, natural gas, petroleum, sand and gravel.
Lawrence	10	6	Sand and gravel.
Lee	W	W	Stone.
Lowndes	W	W	Clays, sand and gravel.
Macon	1,477	2,069	Sand and gravel.
Madison	W	W	Stone, sand and gravel, clays.
Marengo	W	W	Cement, stone.
Marion	W	W	Coal, clays, sand and gravel.
Marshall	W	W	Stone, sand and gravel, clays.
Mobile	66,530	82,674	Petroleum, cement, natural gas, sand and gravel, stone, natural gas liquids, clays.
Monroe	1,033	1,379	Petroleum, natural gas, sand and gravel.
Montgomery	W	W	Sand and gravel, clays.
Morgan	W	W	Stone.
Randolph	761	W	Mica.
Russell	W	W	Clays, sand and gravel.
St. Clair	W	W	Cement, coal, clays, stone.
Shelby	72,153	82,377	Lime, cement, stone, coal, clays.
Sumter	W	W	Sand and gravel, clays.
Talladega	W	W	Stone.
Tuscaloosa	W	68,771	Coal, sand and gravel.
Walker	167,515	W	Coal, clays.
Washington	17,989	20,072	Petroleum, natural gas, stone, natural gas liquids, salt, sand and gravel.
Winston	19,943	12,295	Coal.
Undistributed ³	473,128	615,690	
Total ⁴	968,973	1,029,536	

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

¹The following counties are not listed because no production was reported: Bullock, Butler, Chambers, Cleburne, Coosa, Covington, Greene, Lauderdale, Limestone, Perry Pickense, Pike, Tallapoosa, and Wilcox.

²Values for petroleum and natural gas were based on an average price per barrel for the State.

³Includes some petroleum which cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Alabama business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,440	1,480	+2.8
Unemployment ----- do-----	111	100	-9.9
Employment (nonagricultural):			
Mining ----- do-----	12.5	13.5	+8.0
Manufacturing ----- do-----	321.9	340.0	+5.6
Contract construction ----- do-----	63.3	69.2	+1.3
Transportation and public utilities ----- do-----	59.9	62.4	+4.2
Wholesale and retail trade ----- do-----	229.3	243.9	+6.4
Finance, insurance, real estate ----- do-----	50.4	52.4	+4.0
Services ----- do-----	165.6	174.6	+5.4
Government ----- do-----	247.5	249.9	+1.0
Total nonagricultural employment ----- do-----	1,155.4	1,205.9	+4.4
Personal income:			
Total ----- millions-----	\$16,693	\$12,714	-23.8
Per capita ----- do-----	\$4,618	\$5,106	+10.6
Construction activity:			
Number of private and public residential units authorized ----- do-----	12,782	17,235	+34.8
Value of nonresidential construction ----- millions--	\$311.0	\$278.8	-10.4
Value of State road contract awards ----- do-----	\$129.2	\$192.0	+48.6
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,243	1,493	+20.1
Mineral production value:			
Total crude mineral value ----- millions--	\$969.0	\$1,029.5	+6.2
Value per capita, resident population ----- do-----	\$268	\$281	+4.9
Value per square mile ----- do-----	\$18,775	\$19,949	+6.3

^P Preliminary.

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

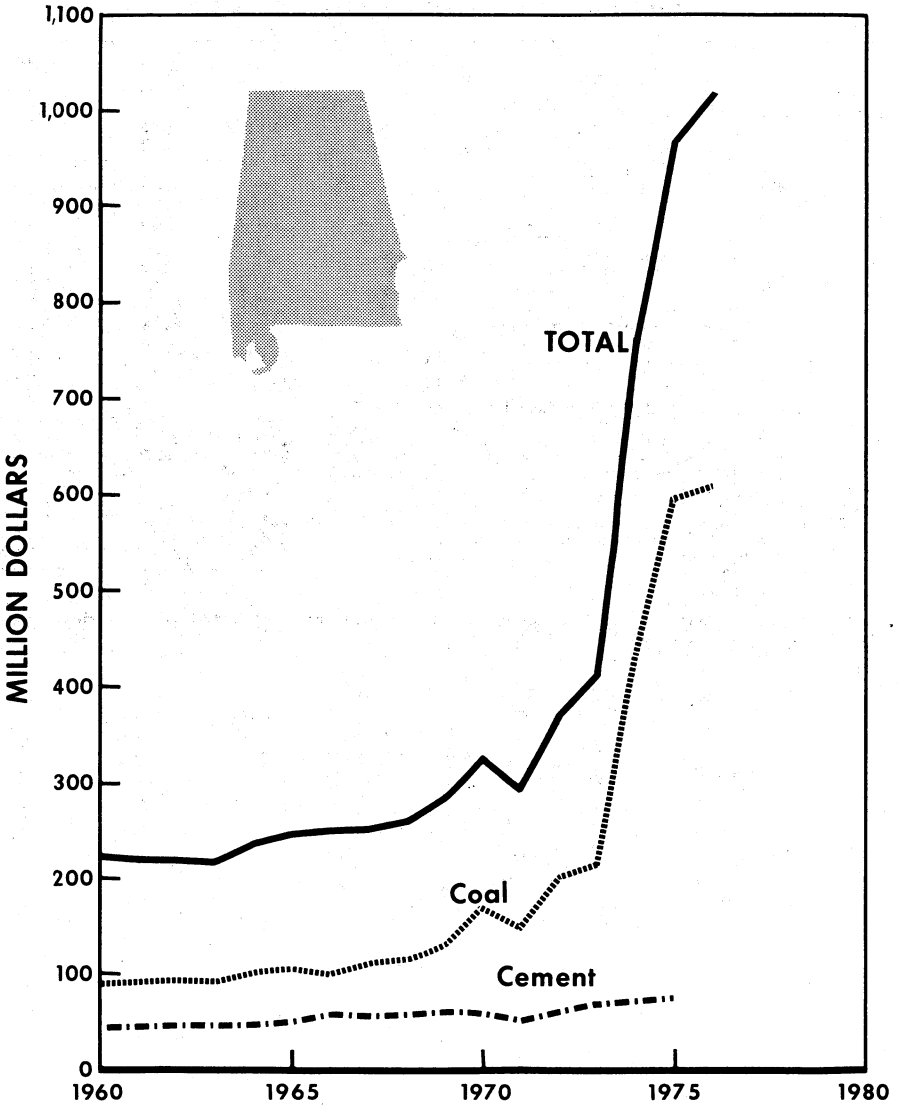


Figure 1.—Value of coal, cement, and total value of mineral production in Alabama.

alumina (69,000 tons). Imported commodities included coal (631,000 tons), bauxite (1.6 million tons), rutile (49,000 tons), ilmenite (45,000 tons), manganese (77,000 tons), and iron ore (1 million tons). Coal imports were received from the Republic of South Africa. In addition, general port tonnage included nearly 3.8 million tons of ore, mostly iron ore. The Alabama State

Docks purchased 143 acres of waterfront property for \$11 million from the Illinois Central Gulf Railroad. The land is needed for a southward expansion of the docks to prepare for the expected increase in port traffic when the Tennessee-Tombigbee Waterway is completed.

Trends and Developments.—Alabama Power Co. (APC) purchased approxi-

mately 10.8 million tons of coal for use in its facilities, an increase of 11% over the 1975 figure. Approximately 4 million tons was purchased on the spot market. Average price for all coal purchased was between \$23 and \$24 a ton, 9% more than in 1975 and 52% more than in 1974. Spot market purchases will be reduced when the new Jim Walter Resources coal mine goes into full production. Approximately 80% of the energy supplied by APC is generated in coal-fired steamplants. APC's Unit No. 1 at the Joseph M. Farley nuclear plant was 95% complete at yearend. The unit, with a capacity of 860,000 kilowatts, was scheduled for commercial operation in mid-1977. Unit No. 2 was 43% complete and was scheduled for operation in 1979. Unit No. 1 of the James H. Miller, Jr., steam plant, near Birmingham, was 40% complete. The coal-fired unit, 660,000 kilowatts, was scheduled for operation in 1978. Units Nos. 2 and 3 were scheduled for operation in 1981 and 1982. APC postponed indefinitely plans for the \$2.9 billion four-unit Alan R. Barton nuclear plant near Clanton, but land acquisition in the area will continue. The first two units, initially slated to go into operation in 1984 and 1985, will be delayed 1 year each. The third and fourth units are being delayed beyond the company's 10-year planning period. APC is building the State's first solar energy structure in Montevallo, Work, which began in October, was scheduled for completion late in 1977. The \$1.5 million structure has the support of Energy Research and Development Administration (ERDA).

Southern Natural Resources, Inc., Birmingham, contracted with the State of Alaska to purchase 650 billion cubic feet of gas from the North Slope, subject to approval by the Federal Power Commission. Construction of the liquefied natural gas receiving terminal near Savannah, Ga., continued, with first deliveries from Algeria expected in 1978.

Republic Steel's Operation Dixie, an expansion project to increase ingot capacity by 1 million tons per year, was postponed indefinitely because of the economic recession's effect on the company's shipments and earnings. The \$350 million project, which had been scheduled for completion in 1979, included a new blast furnace, an

85-oven coke battery, and numerous additions to other facilities.

Southern Railway signed a contract with Harbert Construction Corp. for the design and construction of a \$13 million coal transloading, storage, and blending facility at Pride, on a 230-acre site on the Tennessee River. The facility will receive barged coal from mines along the Ohio-Mississippi River system where it will be conveyed to a stockpile. It will then be blended and conveyed to unit trains for shipment to Georgia powerplants. The facility, which was scheduled for completion late in 1977, will be able to handle up to 10 million tons of coal per year.

Kerr-McGee's new synthetic rutile plant, under construction, was expected to be operational early in 1977. The plant, in the Theodore Industrial Park, will process ilmenite from Australia and produce 110,000 tons of synthetic rutile per year for use in Kerr-McGee's Hamilton, Miss., plant and in a proposed plant in Mobile.

Aluminum Company of America started recovering gallium concentrates from its Bayer process alumina plant in Mobile. The increasing demand for gallium justified the minor modification of existing facilities.

Koppers Co. was evaluating a \$30 to \$40 million expansion of the Woodward coke plant, which would increase capacity by about 80%. The program would expand the operations to 100 ovens and would take about 2 years to complete. The ovens would produce either foundry or blast furnace coke.

Southern Electric Steel Co., Birmingham, a division of Ceco Corp., completed installation of a three-strand billet continuous-casting machine, to be fed by two electric furnaces of 12- and 16-ton capacity, with a combined annual output rated at 100,000 tons. These two furnaces were expected to be replaced in 1978 by a 50-ton electric furnace with an annual capacity of about 200,000 tons.

The Corps of Engineers issued a permit to Mobile River Coal Handling Facility, Inc., to construct a coal-handling facility on the Mobile River just south of Bayou Sara. The facility, which will complement the State Docks McDuffie Terminal, will be served by two railroads and barges. It will have a capacity of 8 million tons per

year and will have a storage capacity of 1.3 million tons. Completion date for the \$30 million project was January 1978.

A Federal court turned down Mobil Oil Corp.'s latest bid seeking permission to drill an exploratory well in Mobile Bay. The court ruled that Mobil should take its case for bay drilling into the Alabama State courts. The Alabama Water Improvement Commission has prohibited all oil companies from such drilling. Mobil has been involved in numerous courtroom and State agency struggles to drill in the bay since it leased 20,000 acres from the State in 1969.

Legislation and Government Programs.—The Alabama Surface Mining Reclamation Commission took over the enforcement of the 1975 Reclamation Act, which is directed only to coal operations, from the Department of Industrial Relations on December 1, 1976. The seven-member commission was appointed in June and held its first meeting in July. The staff members maintain offices in Jasper. The Department of Industrial Relations will continue to enforce the 1969 Reclamation Act, which now pertains only to noncoal operations.

The Geological Survey of Alabama (GSA) and the National Aeronautics and Space Administration are working on a project to inventory strippable coal reserves and areas already mined. Satellite and aerial photographs, along with industry-furnished information, are being utilized. Reports issued by GSA includes studies on basic geology, fossils, energy distribution, water surveys, mineral resources, and a directory of active mines and quarries. A newly created Coal Information Center was established to assist landowners and coal operators in obtaining information on coal reserves and leasing. The State Oil and Gas Board published a report outlining rules and regulations governing oil and gas in Alabama.

The Alabama Development Office developed a comprehensive framework for planning on the State level. Information to assist State, regional, local, and private agencies in their understanding of constraints for development is presented in a seven-volume series of reports entitled "Planning Considerations." Subject areas include existing land use, land ownership, soils, topography, mineral resources, floods, and energy resources.

The Department of Industrial Relations is working with the Tennessee Valley Authority to reclaim abandoned mine areas in north Alabama. The 5-year program, funded for slightly more than \$1 million, is expected to reclaim up to 5,000 acres. Counties affected include Blount, Cullman, DeKalb, Etowah, Jackson, Marion, and Winston.

The 1976 session of the State Legislature passed a new Coastal Area Act. This Act repealed the 1973 Coastal Development Act, reconstituted the Coastal Area Board, provided for the formation of a Citizens' Advisory Committee, defined the coastal zone boundary (10-foot contour), assigned the responsibility for operation of the coastal area program to the Coastal Area Board, and provided for establishment of an office in the coastal area.

Development on the Tennessee-Tombigbee Waterway continued. During the year the Corps of Engineers let eight major contracts totaling over \$81 million. The contracts were for a lock and dam, dredging, railroad relocation, reservoir clearing, and excavation.

A comprehensive 5-year study on the effect of strip mining sediment on water quality in the State is now underway by the U.S. Geological Survey. The test site is in Morris in north Jefferson County where two streams, part of a drainage area for surface mining, are being monitored. The study is in cooperation with Hallmark Mining Co.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels accounted for 78.8% of the total value of mineral production, with bituminous coal value alone accounting for 59.4% of the total.

Coal (Bituminous).—Coal production decreased 4.9%, reflecting the strike interruption that occurred in midyear. Average unit price increased from \$26.53 per ton to \$28.37 per ton. Domestic demand remained strong, with some conversions to

coal use in the industrial sector. The export market increased from 2.4 million tons in 1975 to 2.9 million tons in 1976. Slow development at Jim Walter Resources, Inc.'s new mines prevented a larger export tonnage. Exploration activity continued along with continued development of several underground mines.

Surface mines accounted for 65.6% of the production, compared with 66% in 1975, and the number of operating mines increased from 216 to 236. Underground production is expected to increase with continued development of new mines.

Jefferson, Walker, and Tuscaloosa Counties were the main producing counties, with 72% of the total tonnage, compared with 74% in 1975.

Jim Walter Resources, Inc., received the second installment, \$20 million, of a \$40 million, 9.5% loan from seven Japanese companies. Six of these companies have agreed to purchase 3 million tons of metallurgical coal annually from underground mines now under development. The first installment, \$10 million, was received in July 1975, and additional \$5 million installments were scheduled to be received in 1977 and 1978.

One of Jim Walter Resources, Inc.'s mines, the 76-year old Flat Top mine, is being phased out and replaced by the \$7 million Nebo mine, at which metallurgical-grade coal will be recovered from the Mary Lee seam 10 miles east of Flat Top. The new Nebo mine and the older Bessie mine will have a combined annual production of 900,000 tons. By yearend, two additional ventilation shafts were under development at Blue Creek No. 3 with two more planned for 1977. The original mining layouts and production schedules designed around the continuous mining systems at Blue Creek mines 4, 5, and 7, now under development, were being modified to accommodate long-wall mining systems to the maximum extent possible.

United States Steel has plans to develop a new underground coal mine at Gurnee, near Helena, in Shelby County. The mine will be developed in the Gholson seam in the Cahaba field, and the coal is considered high volatile and low sulfur

(0.6%). The mine will have a capacity of about 500,000 tons per year, and the coal will be used at nearby steel mills. Development work was expected to start in 1977, with operation of the mine scheduled in 1978.

Development continued at United States Steel's Oak Grove underground coal mine southwest of Birmingham. The 6-mile conveyor to carry the coal to the preparation plant was completed. When initial development of the mine is completed in 1979, production is expected to be 1.5 million tons per year, with an ultimate production of 3 million tons per year. The seam mined, the Blue Creek, is at a depth of approximately 1,100 feet.

Peabody Coal Co. closed its Warrior mine, near Hueytown. The mine was closed temporarily in 1975 during repairs to a lock and dam on the Warrior River. With virtual depletion of reserves and increasing costs of production, the decision was made not to reopen the mine.

Mead Corp. planned to build a new coal washer at Mulga to improve quality and reduce transportation costs. In addition, new mining equipment was on order, with full production scheduled in 4 to 5 years, adding 60% to current output.

The equipment and coal-related assets of Lloyd Wood Coal Co., Tuscaloosa, were sold to the Warrior River Coal Co., a subsidiary of the Louisiana Land and Exploration Co. (LL&E). Assets to be acquired include operating equipment and mineral leases with estimated reserves of about 10 million tons of low-sulfur coal. This acquisition marks LL&E's first entry into coal mining.

Drummond Coal Co., Jasper, completed assembly of its second 78-cubic-yard dragline in the Brookwood area, and operation started in midyear. A third 78-cubic-yard unit was 50% complete at Arkadelphia in Cullman County, and a fourth for use at Flat Top in Jefferson County was received. A 115-cubic yard dragline was on order and was expected to be operational by mid-1979. The expansion is expected to result in a production rate of 8 million tons of coal per year by the early 1980's.

Table 4.—Alabama: Bituminous coal production, by type of mine and county, in 1976
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Under-ground	Surface	Under-ground	Surface	
Bibb -----	--	4	--	169	\$4,870
Blount -----	1	19	4	685	18,281
Cherokee -----	--	8	--	105	2,558
Cullman -----	--	18	--	738	17,655
De Kalb -----	--	13	--	367	7,863
Etowah -----	--	2	--	W	W
Fayette -----	1	4	W	227	32,453
Franklin -----	--	9	--	248	6,003
Jackson -----	1	4	W	639	W
Jefferson -----	12	27	3,892	2,364	206,043
Lamar -----	--	1	--	W	W
Marion -----	2	24	W	731	14,886
St. Clair -----	--	12	--	98	1,926
Shelby -----	--	3	--	504	W
Tuscaloosa -----	--	21	--	2,757	67,940
Walker -----	4	51	2,696	3,853	188,066
Winston -----	--	16	--	505	12,295
Total ¹ -----	21	236	7,406	14,131	611,069

W Withheld to avoid disclosing company proprietary data; included in "Total."

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

Natural Gas.—Gas production increased 9.6% over that of 1975. The startup of plant facilities in the Chunchula and Hatter's Pond fields was the main reason for the increase in gas and condensate production during the year.

Mobile Gas Service Corp. and Getty Oil Co. signed an agreement whereby Mobile Gas will purchase up to 10 million cubic feet of gas per day, and possibly more. The firm presently uses up to 110 million cubic feet per day. Getty is continuing to develop the Hatter's Pond field, and its \$5.5 million gas processing plant went on-stream during the year.

Activity in the Warrior Basin increased during the year. The Star field in Lamar County, consisting of three gas producers, was named during the year. In Fayette County, Terra Resources discovered an encouraging productive area from the Carter sand. In addition, offsets were drilled to several existing fields and producing areas in the basin. No new production came on-stream, owing to limited pipeline facilities, but construction of a pipeline was underway and scheduled for completion early in 1977. Drilling activity was expected to increase on completion of this pipeline.

Petroleum.—Oil production increased 9.1% over that of 1975. Activity remained at a relatively high level. During the year,

131 wells received permits by the State Oil and Gas Board. Of these, 64 were field wells and 67 were wildcat wells; 43 wells were in north Alabama and 88 in south Alabama. Of the wells permitted, 76 were completed, 35 were dry holes, and 41 were producers. Of the producers, 28 were field wells and 13 were wildcat wells. At year-end there were 55 actively drilling or permitted locations.

Mallard Exploration, Inc., of Midland, Tex., announced plans for expansion of its petroleum-treating facility in the Big Escambia Creek gasfield near Atmore. The \$12 million expansion is expected to be completed in mid-1977. The plant, owned by Exxon Corp., Mallard, and several other companies, is operated by Mallard. After the expansion, output of the facilities is expected to be 12,000 barrels per day of condensate, 25 million cubic feet per day of natural gas, and 850 long tons per day of sulfur.

In Choctaw County, south Alabama, three new Smackover fields were discovered. The West Barrytown field was discovered by Harkins and Co., the Wimberly field by Midroc Oil Co., and a third field by Pruet and Hughes.

Development of the Chunchula and Hatter's Pond fields in Mobile County continued. In the Chunchula field, 17 producers were completed, 5 wells have been

permitted, and 2 wells have been permitted as productive extensions of the field. In the Hatter's Pond field, nine producers were complete, and three wells were at various stages of completion.

The first oil produced in the 3-year-old Fanny Church field, northeast of Flomaton, has been piped to the Flomaton treating facility by Exxon. Production initially ran to 1,200 barrels per day from four wells. From Flomaton, the partially processed petroleum is piped to Jay, Fla.

Marion Corp., Mobile, completed a 26-mile pipeline from north Mobile County to its refinery in Theodore. The 10-inch pipeline, constructed at a cost of nearly \$3.5 million, will be operated and maintained by Western Crude Oil Co.

NONMETALS

Nonmetals accounted for 21% of the State's total mineral production value. Nearly all commodities registered increases in production and value, a complete reversal of 1975 figures.

Cement.—Cement accounted for the bulk of the value of nonmetallics. Portland cement was produced at seven plants in the State; three plants were in Jefferson County, and there was one plant each in Shelby, Mobile, St. Clair, and Marengo Counties.

Portland cement shipments in 1976 totaled 2,133,892 tons, an increase of 8.5%. Portland cement shipments were valued at more than \$70 million, an increase of 12.4%. Unit value increased from \$31.81 per ton to \$32.98 per ton. Stocks of portland cement at yearend 1976 were 223,449 tons, an increase of 4.6%.

Shipments of masonry cement during 1976 were 314,057 tons, an increase of 20.0%; value increased to nearly \$14 million, or 33.3%.

The end uses for portland cement were as follows: Ready-mix concrete, 58.5%; concrete products, 18.6%; building materials, 7.9%; highway contractors, 6.1%;

Table 5.—Alabama: Portland cement salient statistics
(Short tons)

	1975	1976
Number of active plants -----	7	7
Production -----	1,994,776	2,097,694
Shipments from mills:		
Quantity -----	1,967,597	2,133,892
Value -----	\$62,598,659	\$70,365,440
Stocks at mills, Dec. 31 -----	213,541	223,449

Table 6.—Alabama: Masonry cement salient statistics
(Short tons)

	1975	1976
Number of active plants -----	7	7
Production -----	265,907	311,996
Shipments from mills:		
Quantity -----	261,811	314,057
Value -----	\$10,253,451	\$13,670,992
Stocks at mills, Dec. 31 -----	30,603	26,558

and other uses, 8.9%. This distribution was similar to that of 1975.

Raw materials used in making cement include 1,612,386 tons of cement rock, 371,087 tons of clay, 97,337 tons of shale, and limestone, oystershell, and other materials.

Clays.—Production of common clay decreased 6.7%, that of fire clay increased 49.6%, and that of kaolin increased 6.5%. Thirty companies mined clay at 46 pits: 19 companies mined common clay at 28 pits, 7 companies mined fire clay at 9 pits, 4 companies mined kaolin at 8 pits, and 1 company mined bentonite at 1 pit. Of the total production of clays, 80% came from 19 pits.

Lime.—Production of lime exceeded 1 million tons for the second time. Production came from five plants in Shelby County and increased 2.4%, with value increasing 11.4%. Major uses include basic oxygen steel furnaces (BOF's), paper manufacture, and water purification.

Table 7.—Alabama: Lime sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Steel, BOF -----	808	8,836	W	W
Paper and pulp -----	301	8,780	317	10,143
Water purification -----	108	3,153	112	3,735
Sewage treatment -----	62	1,823	63	2,044
Soil stabilization -----	34	1,250	55	1,911
Steel, electric -----	31	892	W	W
Mason's lime -----	13	464	12	428
Aluminum and bauxite -----	9	250	W	W
Sugar refining -----	6	172	W	W
Food and food products -----	3	78	W	W
Tanning -----	2	47	W	W
Other uses ¹ -----	115	3,659	451	14,492
Total ² -----	985	29,404	1,009	32,753

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

¹ Includes other construction lime, other metallurgy, open-hearth steel furnaces, other chemical uses, alkalis, precipitated calcium carbonate, petroleum refining, sulfur removal (1976), calcium carbonate, agriculture, oil well drilling, finishing lime, ore concentration, insecticides (1976), fertilizer (1976), and uses indicated by symbol W.

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

Mica.—Western Mica Co. produced scrap mica at its Heflin operation from material mined in Randolph County. Alabama ranked second in the Nation in the production of scrap mica.

Mullite.—Harbison-Walker Refractories manufactured synthetic mullite at its Eu-faula operations from material mined in Henry County.

Salt.—The Olin Corp. produced salt from well brines in Washington County for use in chemical manufacture.

Sand and Gravel.—Sand and gravel production increased 30.2% while value increased 20.5%. Sand and gravel was pro-

duced at 95 operations in 38 counties, up from 73 operations and 33 counties in 1975. Nearly 97% of all the sand and gravel was used for construction purposes with the balance for industrial purposes. Of the total production, 68.1% was sold or used commercially, with the balance being sold or used for publicly funded projects.

The major portion was shipped by truck with lesser amounts transported by railroad and water. The top 12 producing companies mined 60% of the total tonnage produced. Leading counties were Montgomery, Mobile, Elmore, and Macon.

Table 8.—Alabama: Construction and industrial sand and gravel sold or used

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	5,562	\$6,890	\$1.24
Gravel -----	6,062	12,795	2.11
Total -----	11,624	¹19,683	1.69
Industrial:			
Sand -----	399	1,250	3.13
Gravel -----	---	---	---
Total -----	399	1,250	3.13
Grand total -----	12,023	20,933	1.74

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

Table 9.—Alabama: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction aggregates:			
Nonresidential and residential construction ..	4,531	\$8,786	\$1.94
Highway and bridge construction			
Other uses (dams, waterworks, airports, etc.) ..			
Concrete products (cement blocks, bricks, pipe, etc.)	2,128	3,877	1.82
Asphaltic concrete aggregates and other bituminous mixtures	1,077	2,526	2.35
Roadbase and coverings	2,345	2,381	1.02
Fill	1,435	1,971	1.37
Other uses	110	144	1.31
Total ¹	11,624	19,683	1.69

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

Stone.—Production of stone increased 7% to a record 23.8 million tons valued at \$65.4 million. Value increased only 6.4%, indicating a decline in the average unit value. Crushed stone was produced by 27 companies at 51 quarries for cement, concrete, roadbase stone, and other uses. Shelby and Jefferson Counties were the major producers, with leading companies being Vulcan Materials Co., Southern Industries, Inc., and Lone Star Industries, Inc. Shipments were 78.2% by truck, 9.4%

by rail, 6.6% by waterway, and 5.8% other or unspecified. Four companies produced dimension stone for cut stone, rough blocks, house stone veneer, and other uses. Output declined 37% to 17,267 tons valued at \$2,234,000. Leading producers were Georgia Marble Co. and Moretti-Harrah Marble Co.

Among the States, Alabama led in output of crushed marble and ranked third in shell and fifth in dimension limestone and dimension marble.

Table 10.—Alabama: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Cement manufacture	4,015	7,138	4,209	8,893
Concrete aggregate	3,446	6,058	3,414	6,432
Dense-graded roadbase stone	2,274	4,414	3,119	6,881
Bituminous aggregate	1,429	2,870	2,499	5,319
Roadstone	2,617	6,828	2,353	4,991
Lime manufacture ²	2,032	6,414	2,021	6,568
Agricultural limestone	1,226	4,833	1,478	5,117
Flux stone	1,322	2,595	1,385	2,718
Surface treatment aggregate	1,026	2,170	861	1,858
Other filler	563	6,643	600	W
Chemicals	W	W	473	W
Riprap and jetty stone	469	1,142	437	1,088
Macadam aggregate	582	1,252	W	W
Railroad ballast	94	179	104	225
Other uses ³	1,129	6,229	862	13,105
Total ⁴	22,220	58,760	23,820	63,200

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

¹ Includes limestone, shell, marble, and sandstone.

² Includes dead-burned dolomite and chemical stone (1975).

³ Includes stone used for mineral food, whiting, filter stone (1975), terrazzo, exposed aggregate, refractory stone, other uses, and uses indicated by symbol W.

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

Sulfur.—Three companies recovered sulfur from four sour-crude oil processing plants in Escambia and Washington Counties. Exxon Co., Mallard Exploration, Inc., and Phillips Petroleum recovered over 200,000 long tons valued at \$9.4 million. Alabama ranked fifth nationally in output of recovered sulfur.

METALS

Aluminum.—Aluminum production increased 27.3% and total value increased 41.8% over the 1975 figures.

Bauxite.—Alabama ranked second in the

Nation in bauxite production. Four companies mined bauxite in Barbour and Henry Counties. Production decreased 4.1%, and total value decreased 22.8%. C-E Minerals, a division of Combustion Engineering, Inc., acquired the newly formed Eufaula Bauxite Milling Co., and is shipping bauxite to its plant in Andersonville, Ga., for use in the production of mullite.

Pig Iron.—Pig iron production decreased 9.0%, and value decreased 7.1%, indicating a slight increase in unit price. Steel production in southeast Alabama decreased 4.6%.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Alumina: Aluminum Company of America.	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant -----	Mobile.
Aluminum smelters:			
Revere Copper & Brass, Inc	Box 191 Rome, N.Y. 13440	---do -----	Jackson.
Reynolds Metals Co -----	Reynolds Metals Bldg. Richmond, Va. 23218	---do -----	Colbert.
Bauxite:			
Eufaula Bauxite Milling Co.	Box 556 Eufaula, Ala. 36027	Mine and plant ---	Barbour.
United States Gypsum Co. ¹	Mexico; Mo. 65265	---do -----	Do.
Wilson-Snead Mining Co --	Box 568 Eufaula, Ala. 36027	---do -----	Barbour and Henry.
Cement:			
Alpha Portland Industries, Inc.	15 South 3d St. Easton, Pa. 18042	Plant -----	Jefferson.
Citadel Cement Corp -----	2625 Cumberland Parkway, N.W. Atlanta, Ga. 30339	---do -----	Do.
Ideal Basic Industries, Inc. ²	821 17th St. Denver, Colo. 80202	---do -----	Mobile.
Lone Star Industries, Inc. ³	1 Greenwich Plaza Greenwich, Conn. 06830	Plants -----	Jefferson and Marengo.
Martin Marietta Corp. ⁴ ----	277 Park Ave. New York, N.Y. 10017	---do -----	Jefferson and Shelby.
National Cement Co -----	Box 3358 Birmingham, Ala. 35205	Plant -----	St. Clair.
Clays:			
American Colloid Co -----	5100 Suffield Court Skokie, Ill. 60076	Mine -----	Lowndes.
Donoho Clay Co -----	Box 843 Anniston, Ala. 36202	---do -----	Calhoun.
Dresser Industries -----	2 Gateway Center Pittsburgh, Pa. 15222	---do -----	Henry.
Riverside Clay Co -----	Box 551 Pell City, Ala. 35125	---do -----	St. Clair.
Coal:			
Alabama By-Products Corp. ⁵	Box 354 Birmingham, Ala. 35210	Underground mines, strip mine, and plant.	Jefferson.
Drummond Co -----	Box 1549 Jasper, Ala. 35501	Strip mines -----	Walker.
Jim Walter Resources, Inc.	Box 10406 Birmingham, Ala. 35202	Underground mines	Jefferson.
Republic Steel Corp -----	Box 6778 Cleveland, Ohio 44101	---do -----	Do.
United States Steel Corp --	Box 559 Fairfield, Ala. 35064	---do -----	Do.
Coke: Empire Coke Co -----	2201 1st Ave., North Birmingham, Ala. 35203	Plant -----	Tuscaloosa.
Ferroalloys:			
Airco Alloys and Carbide --	Box 368 Niagara Falls, N.Y. 14302	---do -----	Mobile.
Alabama Metallurgical Corp	Box 348 Selma, Ala. 36701	---do -----	Dallas.

See footnotes at end of table.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Ferroalloys—Continued			
Tennessee Alloys Corp ----	818 National Bank Bldg. Chattanooga, Tenn. 37402	Plant -----	Jackson.
Tennessee Valley Authority- Union Carbide Corp -----	Muscle Shoals, Ala. 35660 -- Box 176 Marietta, Ohio 45750	---do ----- Plants -----	Colbert and Jefferson.
Woodward Co. ⁶ -----	Woodward, Ala. 35189 ----	Plant -----	Jefferson.
Lime:			
Alabaster Lime Co -----	Siluria, Ala. 35144 -----	---do -----	Shelby.
Allied Products Co -----	Drawer 1 Montevallo, Ala. 35115	---do -----	Do.
Cheney Lime & Cement Co. ⁷ S. I. Lime Co -----	Allgood, Ala. 35013 ----- 500 Southland Dr. Birmingham, Ala. 35226	---do ----- ---do -----	Do. Do.
Natural gas: Black Warrior Petroleum Co., Inc.	Box 1642 Mobile, Ala. 36601	Gasfield -----	Escambia.
Natural gas liquids: Cities Service Oil Co -----	Box 300 Tulsa, Okla. 74102	Plant -----	Mobile.
Petroleum (crude):			
Ancora Corp -----	1 Jackson Place, Suite 620 San Francisco, Calif. 94111	Wells -----	Do.
E. L. Erickson -----	1235 Petroleum Bldg. Jackson, Miss. 39201	---do -----	Choctaw.
Humble Oil & Refining Co -	Box 2180 Houston, Tex. 77001	---do -----	Escambia.
Louisiana Land & Exploration Co.	Box 60350 New Orleans, La. 70160	---do -----	Do.
Patrick Petroleum -----	744 Michigan Ave. Jackson, Mich. 49201	---do -----	Baldwin and Clarke.
Pruett & Hughes Co -----	390 Petroleum Bldg. Jackson, Miss. 39201	---do -----	Choctaw.
Sun Oil Co -----	Box 2880 Dallas, Tex. 75221	---do -----	Mobile.
Petroleum refineries:			
Alabama Refining Co -----	Mobile, Ala. 36600 -----	Plant -----	Do.
Hunt Oil Co -----	Tuscaloosa, Ala. 35401 -----	---do -----	Tuscaloosa.
Vulcan Asphalt Refining Co	Cordova, Ala. 35550 -----	---do -----	Walker.
Warrior Asphalt Co -----	Tuscaloosa, Ala. 35401 -----	---do -----	Tuscaloosa.
Pig iron:			
Republic Steel Corp. ⁵ -----	1629 Republic Bldg. Cleveland, Ohio 44115	Furnaces and mills-	Etowah and Jefferson.
United States Pipe and Foundry Co. ⁵	3300 1st Ave., North Birmingham, Ala. 35202	Furnaces -----	Jefferson.
United States Steel Corp. ⁸ -	Box 599 Fairfield, Ala. 35064	Furnaces and mills-	Do.
Salt: Olin Corp -----	120 Long Ridge Rd. Stanford, Conn. 06904	Brine wells -----	Washington.
Sand and gravel:			
Dixie Sand & Gravel -----	Box 1128 Montgomery, Ala. 36102	Dredge and plant -	Montgomery.
Radcliff Materials, Inc. ⁹ ---	Mobile, Ala. 36601 -----	Dredge -----	Mobile.
W. T. Ratcliff Co., Inc ---	Box 1111 Knoxville, Tenn. 37901	Surface mine and plant.	Clarke.
Southern Industries Inc ---	61 St. Joseph Mobile, Ala. 36602	Pit and dredge ---	Elmore and Montgomery.
Stone:			
Southern Stone Co., Inc ---	2111 8th Ave., South Birmingham, Ala. 35233	Quarry -----	Bibb, Colbert, Lee, Shelby.
Trinity Stone Co., Inc ---	Drawer E Decatur, Ala. 35601	---do -----	Morgan.
Vulcan Materials Co. ¹⁰ ---	Box 7324-A Birmingham, Ala. 35223	Quarries -----	Calhoun, Colbert, Etowah, Franklin, Jackson, Madison, Shelby.
Wade Sand and Gravel Co., Inc.	Box 39048 Birmingham, Ala. 35208	Quarry -----	Jefferson.
Talc: American Talc Co., Inc --	Alpine, Ala. 35014 -----	Surface mine and plant.	Talladega.

¹ Also clays and scrap mica.² Also clays.³ Also stone.⁴ Also lime, stone, and clays.⁵ Also coke.⁶ Also coal, coke, and pig iron.⁷ Also cement.⁸ Also cement, coal, coke, and stone.⁹ Also clays and shell.¹⁰ Also clays and sand and gravel.

The Mineral Industry of Alaska

By Alfred L. Service¹

Mineral production value in Alaska showed an increase of about 30% in 1976, and activity in minerals exploration generally showed substantial gains. There were 46,507 unpatented mining claims in Alaska. The Alaska Division of Geological and Geophysical Surveys processed 13,275 claims in 1976, bringing the total to 59,782 active claims. Fairbanks (5,425 claims), Barrow (2,059 claims), Ketchikan (1,159 claims), Kotzebue (760 claims), and Nenana (763 claims) were the most active recording districts. The Ketchikan recording office had the biggest rush of claim filing since 1969. U.S. Borax & Chemical Corp. molybdenum developments and uranium price increases stimulated most of the activity in southeast Alaska. About \$5.6 million was spent on exploration activity in the area in 1976. During calendar year 1976, there were 80 drilling permits issued by the Alaska Division of Oil and Gas Conservation, compared with 70 permits issued in 1975, reflecting a continuing increase over the past 3 to 4 years. There were 63 permits issued for development wells and 17 for exploration wells.

Real economic growth in Alaska in 1976 was about 15% as measured by the National Bank of Alaska Real Economic Activity Index.² Average statewide civilian non-agricultural employment was ahead by about 6% contrasted with a 27% increase in 1975. Total personal income was up by about 16% indicating strong increases in individual and employment growth. Average employment increased 40% over that of 1975 through the third quarter. The trans-Alaska oil pipeline was the major force with employment reaching a peak of more than 21,000 persons.

Construction in Alaska increased over

previous years' records. Office construction was an important factor among nonpipeline activities. Residential construction was down from 1975 in Anchorage and Fairbanks, but the trend was not evident in the Kenai Peninsula, Kodiak, Juneau, and Cordova areas.

Government, Alaska's largest employer, showed little employment change from 1975. At the end of fiscal year 1976, State general fund balances were about \$504 million, 33% over that of fiscal year 1975. Alaska's petroleum reserves tax brought \$11 million more than expected and real property tax receipts were \$67 million over the estimates. A large portion of the property tax came from levies on oil production hardware. A permanent fund was approved by voters in November that will accumulate not less than 25% of nontax resource values. The fund represents monies to be invested in income generating investments for the benefit of Alaskans.

Supportive industries in Alaska were highlighted by the communications sector in 1976. RCA Alascom invested \$70 million in communications facilities. Employment increases within the sector slowed somewhat from the 1975 surge. Through the third quarter communications, transportation, and utilities increased 1% while trade, service, finance, real estate, and insurance increased at a rate of 6%. Alaska's cost of living continued to increase at a 6.5% annual rate. The sharpest increases were noted in the Anchorage housing rental index, up 12%; gas and electricity, up 17%;

¹State Liaison Officer, Bureau of Mines, Anchorage, Alaska.

²National Bank of Alaska. 1976 Annual Report.

Table 1.—Mineral production in Alaska ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite -----thousand short tons--	2	\$30	--	--
Coal (bituminous) -----do-----	766	W	706	W
Gem stones -----	NA	57	NA	\$60
Gold (recoverable contents of ores, etc.)				
troy ounces--	14,980	2,419	22,887	2,868
Lead (recoverable content of ores, etc.)				
short tons--	--	--	14	6
Natural gas -----million cubic feet--	160,270	48,402	166,072	64,602
Petroleum (crude) -----thousand 42-gallon barrels--	69,834	364,630	63,398	318,789
Sand and gravel -----thousand short tons--	48,145	25,780	74,208	204,788
Silver (recoverable content of ores, etc.)				
troy ounces--	W	W	3,265	14
Stone -----thousand short tons--	8,877	26,649	6,727	20,092
Tin -----long tons--	11	60	--	--
Zinc (recoverable content of ores, etc.)				
short tons--	--	--	(²)	(²)
Value of items that cannot be disclosed:				
Natural gas liquids, platinum-group metals, and values indicated by symbol W -----	XX	12,718	XX	14,019
Total -----	XX	480,745	XX	625,188
Total 1967 constant dollars -----	XX	190,281	XX	224,755

¹ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Value of items that cannot be disclosed." XX Not applicable.

² Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

³ Less than 1/2 unit.

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

(Thousands)

Region	1975	1976	Minerals produced in 1976 in order of value
Alaska Peninsula -----	W	--	
Bristol Bay -----	\$965	--	
Cook Inlet-Susitna -----	8,094	\$5,200	Sand and gravel, stone, gold.
Copper River -----	W	W	Stone, sand and gravel.
Kenai Peninsula ² -----	412,966	381,816	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kodiak -----	696	651	Sand and gravel, stone.
Kuskokwim -----	W	W	Platinum-group metals, gold, sand and gravel.
Seward Peninsula -----	W	W	Gold, sand and gravel, stone, silver.
Southeastern Alaska -----	17,082	13,532	Stone, sand and gravel.
Yukon River -----	W	41,399	Sand and gravel, coal, stone, gold, silver, lead, zinc.
Undistributed ³ -----	40,992	182,588	
Total -----	480,745	625,188	

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

¹ No production was reported in the Aleutian Islands, Bering Sea, Northern Alaska, and Northwestern Alaska Regions.

² Values of petroleum and natural gas are based on an average unit price for the State.

³ Includes gem stones, some sand and gravel, petroleum, and natural gas liquids (1976) that cannot be assigned to specific regions.

⁴ Data do not add to total shown because of independent rounding.

private transportation, up 14%; and medical care, up 12%. Through the end of the third quarter commercial bank deposits increased at an annual rate of 11.7%, down from 26.4% a year ago. Loans increased at an annual rate of 10%, down from 24.5% a year ago.

The State of Alaska received \$1.04 million from the U.S. Department of the Interior in annual revenues collected from the pub-

lic domain administered by the Bureau of Land Management (BLM). The State's share came from revenues collected from mineral leases, public land sales, and other fees. Under the Statehood Act, Alaska receives 90% of the fees collected. A lawsuit between the State of Alaska, the Department of the Interior, and Kenai Peninsula Borough raised the issue of whether this percentage applied to oil and gas leases in

Table 3.—Indicators of Alaska business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	180.0	¹ 157.0	-12.8
Unemployment -----do-----	14.5	13.0	-10.3
Employment (nonagricultural):			
Mining -----do-----	3.8	4.0	+5.3
Manufacturing -----do-----	9.6	10.5	+9.4
Contract construction -----do-----	25.9	30.2	+16.6
Transportation and public utilities -----do-----	16.5	15.9	-3.6
Wholesale and retail trade -----do-----	26.2	28.0	+6.9
Finance, insurance, real estate -----do-----	6.0	7.2	+20.0
Services -----do-----	26.1	28.7	+10.0
Government -----do-----	47.7	47.1	-1.3
Total nonagricultural employment -----do-----	161.8	^{1,2} 171.7	+6.1
Personal income:			
Total -----millions--	\$3,443	\$3,979	+15.6
Per capita -----do-----	\$9,440	\$10,415	+10.3
Construction activity:			
Number of private and public residential units authorized -----do-----	2,903	5,194	+78.9
Value of nonresidential construction -----millions--	\$75.4	\$128.7	+70.7
Value of State road contract awards -----do-----	\$111.8	\$111.8	--
Shipments of portland cement to and within the State thousand short tons--	131	134	+2.3
Mineral production value:			
Total crude mineral value -----millions--	\$480.7	\$625.2	+30.0
Value per capita, resident population -----do-----	\$1,317	\$1,637	+24.3
Value per square mile -----do-----	\$820	\$1,066	+30.0

^p Preliminary.

¹ Because of a difference in the method of determining the total civilian labor force and total nonagricultural employment, these figures appear to conflict; they are reproduced as published in two different publications of the Department of Labor. Resolution of the apparent conflict is possible only by detailed analysis of the data base from which each figure has been derived.

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 Kenai Moose Range. The Department of the Interior is withholding more than \$3 million in lease payments during 1976.

The last section of the trans-Alaska pipeline was installed at Thompson Pass about 20 miles northeast of the Valdez terminal. By yearend the massive project was about 90% complete. More than 807 miles of welding was completed, including ditch excavation for mainline pipe, below ground installation of pipe, construction of pipe support members, and river crossing installations. Work on pump stations and the terminal site will continue through the winter of 1977. Startup was scheduled for fall 1977 barring major difficulties.

El Paso Natural Gas Co. and Alaskan Arctic Gas Pipeline Co. have been joined by Northwest Pipeline Co. in efforts to convince the Federal Power Commission (FPC) and the general public that their proposal for a natural gas pipeline from Prudhoe Bay to the "lower 48" is best for the Nation and the State. The latest proposal calls for a 3.6-foot natural gas pipeline paralleling the trans-Alaska oil pipeline to Fairbanks and then following the

Alaska Highway to Canada. FPC is expected to come to a decision by mid-1977.

The Augustine volcano in lower Cook Inlet erupted on January 22, 1976, and at least five additional major eruptions followed during the next 3 days. Ash clouds reached 45,000 feet, and about 0.5 inch of fine ash fell on the city of Anchorage; ash also fell on Homer, Iliamna, and Seldovia. Mud flows and lava flows were apparent on the slopes of the mountain and the appearance of the crest changed considerably. Additional activity was noted in mid-February.

Legislation and Government Programs.—Guy P. Martin, Commissioner, Alaska Department of Natural Resources, announced a major reorganization designed to improve management of subsurface resources, including petroleum, natural gas, and minerals. Michael Smith, present Director, Alaska Div. of Lands, will assume an additional title of Assistant Commissioner of Lands, Minerals, and Energy. The reorganized department will consist of a Division of Minerals and Energy Management (DMEM) and a Division of Land Manage-

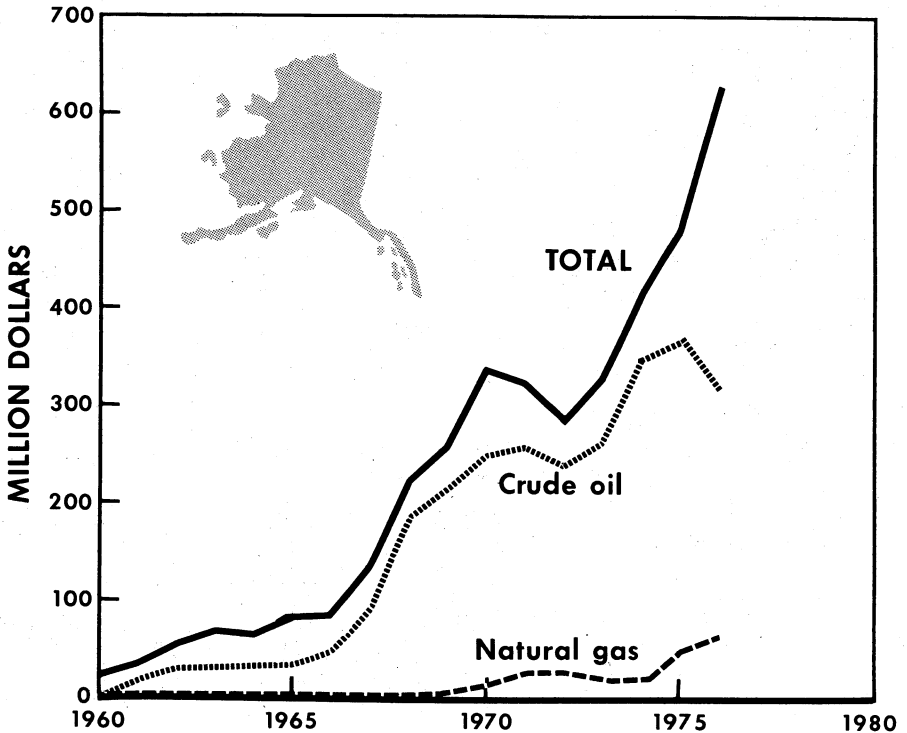


Figure 1.—Value of crude oil, natural gas, and total value of mineral production in Alaska.

ment (DLM). The DMEM will include a minerals section, five high-level petroleum specialists, and several minerals specialists. The DLM will include lands and waters, classification, and forestry sections with district offices in Fairbanks, Anchorage, and Juneau. The DMEM will also have leasing, mining, and petroleum sections all located in Anchorage.

The 1976 Alaska State Legislature authorized the Governor to convey certain lands in Alaska to the Federal Government in accordance with the Cook Inlet Trade Agreement. The conveyance would pass all States rights in the land, including the mineral subsurface estate, waiving provisions contained in the constitution that restrict the State's right to alienate minerals and which authorizes exchanges of land with Native corporations on the basis of equal value. A suit questioning the constitutionality of legislative and executive consent to the exchange was filed with the Alaska Superior Court. In June, the court found the

statute unconstitutional and enjoined the transfer. The State of Alaska and Cook Inlet Region, Inc., appealed the decision to the Alaska Supreme Court. The Supreme Court ruled that the three-way trade was constitutional and an appeal was immediately filed with the U.S. Supreme Court. The plaintiffs also applied for a stay of the State Supreme Court ruling. A decision by the U.S. Supreme Court is expected early in 1977.

Commissioner Martin announced in December that the State had filed for 2.8 million acres of land under the land selections section of the Statehood Act. Generally, lands with high potential for intensive land use, community value, agriculture, and with a high revenue generating resource potential were selected. About 40% of the land is usable for intensive purposes, 3% is agricultural, 15% falls in the top half of coal potential, 15% in hard minerals potential, and 15% in forestry. Many of the values overlapped with more than 60% of the land

having fish and game habitat value, 40% with coal and local community values, and 50% related to coasts, river, transportation, or access.

As of April 1, 1976, the State of Alaska has patent to more than 16 million acres under the Alaska Statehood Act of 1958 with an additional 19,280,000 acres tentatively approved for patent. Since statehood, approximately 69,000,000 acres have been selected from a total of 104,450,000 acres.

The 1976 Alaska Legislature voted to buy back \$25 million worth of oil and gas leases in Kachemak Bay. The State sale was held under Governor Egan's authority in 1973, and Shell Oil Co. and Standard Oil Co. of California were major bidders. The sale was contested by environmental factions who claimed the State violated public notice laws in the original sale. The legislature and Governor Hammond contended the sale was illegal and Hammond proposed legislation to condemn the leases. The Alaska State Supreme Court ruled that a new trial should be held to determine any violation by the State of the public notice laws.

The U.S. Department of the Interior held an Outer Continental Shelf (OCS) oil and gas lease sale in the northern Gulf of Alaska. The total was \$1.7 billion with high bids totaling more than \$571.8 million. The large bidders were Atlantic Richfield Co., (Arco), Shell Oil Co., and Exxon Corp. Tract 78, the area receiving the highest bonus bid, went to Texaco, Inc., Allied Chemical Corp., Diamond Shamrock Corp., and Champlin Petroleum Co. for \$62,756,352. The second highest bid was \$61,880,000 for tract 42 by Arco, Texas Eastern Exploration Co., and Oil Development Co. of Texas.

The Department of the Interior selected 152 tracts in lower Cook Inlet to be offered at a lease sale in 1977. There were 865,363 acres in an area approximately 110 miles long and 70 miles wide between Kalgin and Barren Islands. Public hearings were held on the draft environmental impact statement (EIS) in Anchorage and Homer. Opposition to the sale was minimal; only one village on the Kenai Peninsula was opposed to the sale.

The General Services Administration (GSA) notified oil, gas, and pipeline companies it was planning the sale of a 600-

mile pipeline from Haines to Eielson Air Force Base near Fairbanks. Included in the proposed sale of the 8-inch line are 11 pump stations, a right-of-way, a dock at Haines with 200 acres of land, tank storage at Haines and Tok totaling 675,000 barrels, and related equipment.

The term of the 10-member Joint Federal-State Land Use Planning Commission (LUPC) was scheduled to end on December 18, 1976, as set forth in ANCSA. The U.S. Congress extended the period and the LUPC will continue to function through June 30, 1979. Through 1978 Congress could take action on Section 17 d(2) National Interest Lands, ANCSA. LUPC findings and recommendations are expected to be a prime source of information and a point of reference in forthcoming debates. The LUPC is still actively involved in land planning decisions in both d(2) and d(1) lands.

Recommendations by the LUPC will be directed toward withdrawn lands and will include advice on management designations for d(2) and d(1) lands, and proposed guidelines for preservation of values and management of uses. The LUPC will consider alternatives to classifications under the four systems; that is, national parks, wildlife refuges, forests, and wild and scenic rivers. LUPC announced it favors a mineral permit and leasing system with revisions in the Mining Law of 1872. It also will consider data and information needs for coastal zone management planning in Alaska and the relationship between Federal, State, and local governments in this planning and management.

Several bills came before the 1976 Alaska Legislature which will directly influence the future of the minerals and petroleum industry. The North Slope Borough will receive added income from increased ad valorem taxes as a result of a bill that raised the tax ceiling of \$1,000 per capita to \$1,500. It is estimated that about \$4.3 million will be diverted from State coffers to the borough.

The Alaska Power Authority was created to provide a means for constructing, acquiring financing, and operating hydroelectric and fossil fuel generating projects. Another bill funded the water resources revolving fund with \$2.5 million for development and conservation of water resources in the State by making loans to eligible utilities.

Governor Hammond proposed a bill to the 1976 legislature imposing a mining license tax on net proceeds over \$50,000. This is a substitute for a bill submitted to the 1975 legislature imposing a mining severance tax. The new bill set a tax schedule on all mining starting with 3% between \$40,000 and \$50,000, \$300 plus 5% on \$50,000 to \$100,000, and \$2,800 plus 7% on net proceeds above \$100,000. The bill did not pass.

The petroleum industry did not receive a tax increase but legislation was enacted to buy back the Kachemak Bay leases and to regulate tanker traffic in Alaskan waters. The tanker bill sets standards for tankers and provides for an insurance fund to cover spills and other liabilities. The Kachemak Bay bill provides for a 1-year moratorium on activity on the leases, another year for negotiation, and a State option for condemnation. The 1976 legislature passed a resolution to establish an oil and revenue study with \$111,000 funding.

President Ford signed Public Law 94-258 on April 5, 1976, creating the National Petroleum Reserve in Alaska (NPR-A). This act officially transferred control of Naval Petroleum Reserve No. 4 (PET-4) from the jurisdiction of the Navy to the U.S. Department of the Interior. This change will be effective on June 1, 1977. The Navy announced plans to drill five exploration wells and two gas wells in NPR-A. Husky Oil Co. of Dallas, Tex., is the Navy's contractor. BLM will monitor exploration activities and the Conservation Division, U.S. Geological Survey, also will have responsibilities in the program. Husky has a 5-year contract with the Navy to drill 26 wells and conduct 10,000 miles of seismic work. The U.S. Department of the Interior will be the contractor after June 1, 1977.

BLM announced proposed regulations for surface management of NPR-A to protect environmental, fish and wildlife, historic, and scenic values during exploration activities. The Utukok River uplands on the southwest side of NPR-A and Teshekpuk Lake on the northeast coast have been set aside by BLM as areas for special management. The 3.9-million-acre Utukok upland has been identified by the Alaska Department of Fish and Game as an important calving ground for the Arctic caribou herd. The 1,733,200-acre Teshekpuk Lake area has been recognized as an important

molting area for migratory birds. Teshekpuk Lake is also the largest lake in Alaska with the unique Arctic characteristic of orienting itself to the direction of the prevailing winds.

President Ford signed Public Law 94-579, the Federal Land Policy and Management Act of 1976 (Organic Act on October 21, 1976). The law established a policy of continued Federal stewardship and set guidelines for the administration and management of these lands and their resources by BLM. Under provisions of this act, BLM will monitor all activities on the public domain. The act requires all persons holding mining claims under the Mining Law of 1872 to record these claims with BLM. In December 1976, BLM published regulations concerning surface management of public land under U.S. mining laws. Public hearings on these regulations are scheduled for 1977.

Alaska Coastal Zone Management Program.—President Ford signed Public Law 94-370, the Coastal Zone Management Act amendments of 1976, on July 26, 1976. This act authorized \$1.6 billion for an energy development impact assistance program and for enabling an extension of the scope of the existing Coastal Zone Management (CZM) Program. Planned and existing offshore and coastal onshore petroleum activity in Alaska has made this law an important adjunct to Alaska's CZM planning process.

The 1976 Alaska Legislature passed a resolution acknowledging the rich resource values of Alaska's coastal zone, both offshore and onshore, and established a legislative-executive branch committee to review and coordinate coastal management activities. This resolution also called for a compilation of all existing laws and regulations applying to the coast. A working group of four legislators and four representatives of the Governor was organized to study and evaluate Alaska's CZM policy. A report by the committee to the legislature will include an explanation of the benefits of a CZM program for Alaska and a definition of roles by Federal, State, local, and unorganized borough governments in the State's CZM program. This committee drafted a bill titled "An Act Relating to the Management of the Coastal Resources of the State; and Providing for an Effective Date," which is expected to be presented to the

1977 legislature. The proposed bill has three main parts. First, borough and organized communities are required to develop local CZM plans for review by the Alaska Coastal Management Council (ACMC). Second, State agencies must issue permits and conduct regulatory activity consistent with approved local programs. Third, the State will use CZM guidelines and approved local plans to assure that Federal agencies respect State and local views regarding protection and development of coastal resources.

There are five basic objectives to the State's Coastal Management Program: (1) To achieve coordinated development and utilization of coastal biological, cultural, aesthetic, and energy related resources without emphasizing any single resource at the expense of any other; (2) to manage renewable resources in a manner designed to attain maximum sustained yield; (3) to attain optimum time-distribution utilization of nonrenewable resources to achieve maximum economic and cultural gain; (4) to achieve a balance in the human use and natural replenishment of the coastal zone ecosystem at an optimum level; and (5) to retain the aesthetic, ecological, and cultural diversity necessary to maintain economic and ecological resilience to human intervention in the coastal area.

The State is presently studying onshore impacts of offshore oil and gas development as part of its CZM program effort. Direct planning assistance will be provided to local communities and regions involved in OCS activity.

Alaska Native Corporation Activities.— A 13th Native corporation was incorporated on December 31, 1975, to meet the needs of nonresident Alaska Natives. The corporation distributed 50% of its share of Native funds received as specified in the Alaska Native Claims Settlement Act; the other 50% will be used in two major areas—investments and nonprofit programs. By the end of 1976, the membership of the new organization totaled 4,500. The headquarters of the as yet unnamed corporation is in Seattle, Wash.

The remaining 12 northern corporations have invested their monies in a variety of ventures. Ahtna, Inc., has been active in pipeline construction particularly in sand and gravel production. Bristol Bay Native Corp. probably has the greatest potential

for revenue from subsurface resources. The corporation, presently working with Phillips Petroleum Co. in petroleum exploration and Bear Creek Mining Co. in the mineral field, also has interests in transportation, fishing, banking, and hotels. The Calista Corp. has formed a consulting firm specializing in land selections, Earth Science Consulting and Technology (ESCA-TECH), and has been active with other corporations in a consulting capacity. ESCA-TECH has offices in Long Beach, Calif., and Anchorage.

Chugach Native Inc. (CNI) explored for petroleum in the Icy Bay region. An agreement with Phillips Petroleum Co. provided for a 50-50 joint venture in the event oil is discovered. CNI also has an agreement with Alyeska Pipeline Service Co. in Valdez to handle oil spills. The oil spill contingency team is responsible for cleanup and containment of marine oil spills and for reporting and supervising land spills in the terminal area. Chugach Development Corp., a subsidiary of CNI, and Anchorage Helicopters provide support services to off-shore rigs in the northern Gulf of Alaska. Cook Inlet Region Inc. explored for minerals in its selected area through the services of an Alaska consulting firm. A proposed trade of land between the State, the Federal Government, and Cook Inlet will give the corporation some important and valuable mineral resource lands. The trade was held up because of a lawsuit and a decision will be rendered by the Federal courts.

Doyon, Ltd. has an agreement with Louisiana Land and Exploration Co. (LL&E) to drill exploratory wells in the Kandik Basin area. Extensive seismic and geophysical surveys also will be conducted. The first exploratory hole was completed and plugged but company officials have neither confirmed nor denied rumors that it was a dry hole. The contract with LL&E calls for drilling four holes over a 2-year period. Doyon also explored for minerals on their selected land. This native corporation signed an agreement with a consortium of five major mining companies to conduct the exploration program. Doyon announced it intends to extend the minerals search to the Yukon Territory, Canada, to determine if mineralization on Doyon land extends across the border. Alaska International Construction Co. (AIC) and Doyon are partners in a joint venture to maintain a

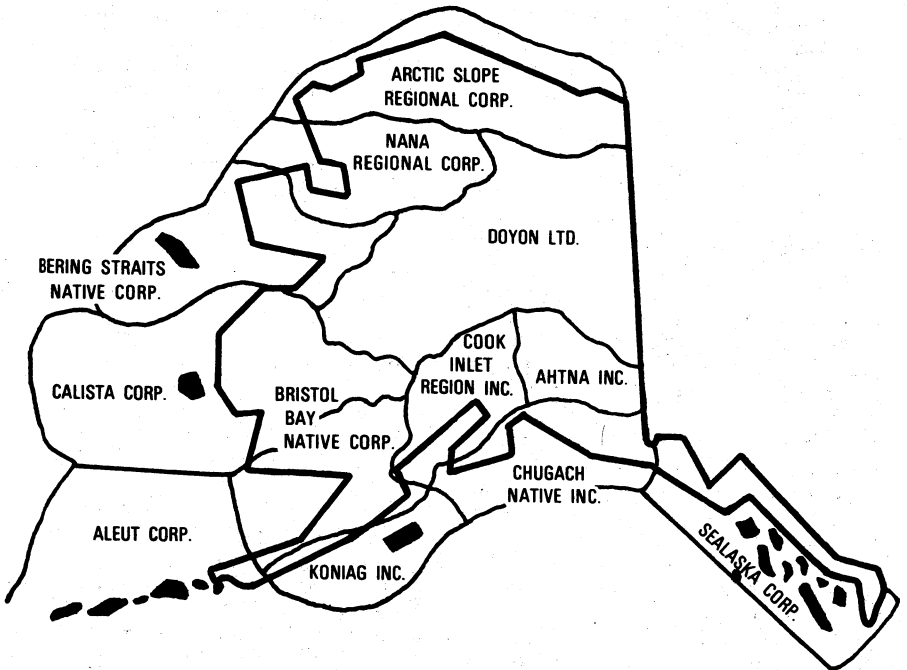


Figure 2.—Alaska's native corporations.

section of the North Slope Highway. Doyon has a similar agreement with AIC for construction of an airstrip, roads, and drill pad in the Kandik Basin. Koniag, Inc., Regional Native Corp., was exploring for hard minerals and oil in the Kodiak area. Standard Oil Co. of California started exploration work in the area in 1974.

NANA Regional Corp. organized NANA Oilfield Services, Inc., which includes a 242-man camp with petroleum distributorship, equipment rentals, and shops on the North Slope and in Kenai. Arctic Utilities, Inc., a subsidiary of NANA, is the only public utility at Prudhoe Bay providing primary and standby power. NANA Security Systems maintains services at 15 pipeline camps and pump stations north of the Yukon River. The 110-person operation also provides security services at Anchorage International Airport and labor services at Pump Station One.

Transportation.—The Alaska Railroad (ARR) reached alltime highs in traffic revenues during fiscal year 1976. Gross revenues of \$53.7 million, the highest in 53 years of operation, were attributed primar-

ily to pipeline-related freight and supplies. The total tonnage hauled by the ARR through November 1976 was 2.4 million short tons, an increase of about 26% over that of 1975. Revenue tons carried increased 17.5% over that of fiscal year 1975, and revenue ton miles increased by 13.7%. A share of this increase can be attributed to more than 20 barge loads of equipment diverted to Seward because of unusual ice conditions in the Chukchi Sea which prevented the barges from reaching Prudhoe Bay.

About 82% of the 2.4-million revenue tons was local freight, the remainder was interstate traffic. Passenger traffic also increased from 81,418 in fiscal year 1975 to 84,483 in fiscal year 1976. Seward became a major port because of pipeline freight and the Valdez yard track system was expanded to handle increased traffic.

A study released by the Alaska Carriers Association showed that revenues for the six major Alaska carriers decreased by \$22.5 million in the first three quarters of 1976, compared with the similar period in 1975.

The Yukon River bridge was completed in 1976, providing the first highway link to the North Slope and Arctic Alaska. The bridge cost more than \$38 million and construction materials included 73,000 cubic yards of concrete, 633 tons of reinforcing steel, and 4,867 tons of construction steel. Design factors for the structure included seismic stresses, severe river breakup conditions, extreme temperature variations, and pipeline load. There were 34 other highway projects completed by the State in 1976 involving more than \$91 million.

The State of Alaska faces an important decision concerning disposition of the trans-Alaska pipeline haul road. In September 1976, Governor Hammond discussed the haul road, its cost, and options for its use. The Alaska Department of Highways and the Alaska Department of Public Safety projected the costs for maintaining and patrolling the road in thousand dollars, as follows:

	1978	1979
Maintenance:		
Operating expenses (summer only) -----	4,133	2,351
Operating expenses (12-month use) -----	15,024	10,307
Capital improvements -----	9,903	--
Total -----	29,060	12,658
Public safety:		
Operating expenses -----	429	642
Capital improvements -----	2,292	--
Total -----	2,721	642

Source: Report of North Slope Haul Road Task Force, 1976.

Public hearings were held in Barrow, Anaktuvuk Pass, Fairbanks, Anchorage, Al-

lakaket-Alatna, and Evansville-Bettles to determine the public feeling concerning the haul road. The people north of the Yukon River maintained the road is not a legitimate part of the State Highway System, it should not be maintained at State expense, and public access should not be granted. This contention was supported by more pressing needs for roads in northern Alaska and the feeling that opening the road to general use could upset existing life styles.

In other hearings, a majority felt maintenance costs should be user supported, and that industry should continue to use the road with special provisions to cover maintenance costs. The question of public access was not well defined. The LUPC recommended that the haul road remain closed to the public for at least 2 years to permit proper planning for future use. The Alaska Growth Policy Council (AGPC) recommended that access be limited by permit to traffic supporting petroleum, mining, and other industrial related activity; that use for vital village services continue; that maintenance and other costs be supported from the State general fund with the costs being offset by tolls or permit fees; and that other uses be subject to priorities of any Federal pipeline scheduling construction. The Governor's North Slope haul road task force recommended the State allow access only to users related to development of mining and of oilfields in the Arctic and for the supply of local communities and that access be controlled through a permit system.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).³—Bituminous coal production in Alaska decreased from 766,000 tons in 1975 to 706,000 tons in 1976. All production came from the Usibelli Coal Mining Co. near Healy. The coal was used at military bases north of the Alaska Range, at electricity-generating plants in the Fairbanks area, at the University of Alaska, and for heat in residences. There were no shipments either to the "lower 48" or to foreign countries.

The Golden Valley Electric Association (GVEA) announced it was proceeding with plans for the proposed construction of a

second coal-fired generating plant at Healy and approached the Fairbanks Municipal Utilities System (FMUS) on participation in the program. The tentative program calls for final design and equipment orders by 1979 and construction by 1980. The plant would go online by 1983-84. An environmental permit application for the 150-megawatt plant has been filed with the State of Alaska.

The Federal Bureau of Mines awarded a \$277,000 contract to study the technological and economic feasibility of mining coal on the North Slope of Alaska. Kaiser En-

³ Conwell, C. Mining Engineer, Alaska Division of Geological and Geophysical Surveys.

gineers of Oakland, Calif., will conduct the 12-month research study. The work will include an evaluation of mining and reclamation techniques, an assessment of mining equipment and its adaptability to Arctic conditions, a study of potential markets for the coal, and an evaluation of transportation methods. Environmental consideration will be important in all phases of the study.

AMAX, Inc., will not exercise its option to purchase the Usibelli coal mine at Healy. The company completed an exploration drilling program on the Usibelli coal leases to determine production potential. AMAX has been converting coal prospecting permits in the Healy coal province to coal leases. AMAX is interested in shipping coal from Alaska to the West Coast of the United States and to Japan.

There were no coal prospecting permits issued by the Alaska Division of Lands in 1976 compared with the 137 in 1975; however, 3 permits were converted to coal leases. Exploration work on coal followed the 1975 pattern. Placer Amex, Inc. of San Francisco, Calif., continued evaluation of its leases in the Beluga area. Mobil Oil Corp. did some exploration work north of the Beluga field and Portland General Electric Co. continued exploration in the Peters Creek area. Consolidation Coal Co. completed an exploratory drilling program near Deep Creek in the Kenai area. The exploration dollar expenditure was considerably lower in 1976, but several coal and electric utility companies were active in the Kenai Peninsula, Beluga, Yentna, and Susitna basins.

Petroleum and Natural Gas.—Drilling activity in Alaska continued to show increases in 1976. There were 80 drilling permits issued, an increase of 14.3% over that of 1975. There were 63 permits for development wells and 17 for exploration wells. There were seven dry holes, six suspended wells, and four drilling wells. No discoveries were announced in 1976. Standard Oil Co. of California set a new drilling depth record for Alaska at 5,392 meters in the Soldotna Creek No. 33-33 well.

Oil production declined 9% in 1976, but part of this was attributed to a 2.9-million-barrel production loss resulting from a fire and explosion on the King Salmon platform in Cook Inlet. Natural gas liquids production increased slightly and natural gas pro-

duction increased 3.6%. Total direct oil and gas income to the State of Alaska in 1976 was \$362 million representing about 42% of fiscal year 1976 total State expenditures. This income included \$2.8 million from oil and gas State lease rentals, \$36.7 million from State oil royalties, \$807,109 from Federal lease rentals, \$4.2 million from Federal oil and gas royalties, \$80 million from State lease bonuses, \$24.4 million from oil production taxes, \$1.5 million from gas production taxes, \$68.4 million from oil and gas property taxes, \$79,194 from State oil and gas conservation taxes, and \$223.1 million from State oil and gas reserves taxes.

Energy Co. of Alaska, a subsidiary of Earth Resources Co., Dallas, Tex., started construction on the initial phase of a petroleum refinery at North Pole. The complex will have a capacity of 25,000 barrels per day and can be expanded to 30,000 barrels per day. Total cost for phase I will exceed \$30 million and startup probably will be September 1977. Energy Co. of Alaska has contracts with Exxon, Arco, and Standard Oil Co. of Ohio for Prudhoe Bay crude oil. Products from the refinery will be industrial turbine fuel for the GVEA's new powerplant and fuel for Alyeska pump stations.

The value of oil produced in 1976 was \$318.8 million which equates to about \$5.03 per barrel. Gas production was valued at about \$64.6 million which averages about 38.9 cents per thousand cubic feet (Mcf). The value of plant products sold was \$3.6 million or about \$4.72 per barrel.

BP Alaska, Inc., and Arco applied to the State of Alaska for approval of a unitization agreement for the Prudhoe Bay field. The State Division of Oil and Gas Conservation will review the proposal and incorporate any new data in the State's reservoir simulation model to determine if the plans are in agreement with good conservation practices. A hearing process will be scheduled in 1977.

Collier Carbon and Chemical Corp. started expansion of its north Kenai ammonia and urea plant. The project will cost between \$230 and \$240 million and will double the capacity to a total of 6,400 tons of chemical fertilizer per day. The new facility is expected to go online in late 1977 as one of the largest complexes on the West Coast. Building modules will be barged to Kenai for the project. Temporary dock fa-

Table 4.—Alaska: Principal natural gas and petroleum companies

Commodity and company	Address	Type of activity	Region
Natural gas:			
Phillips Petroleum Co	Anchorage, Alaska 99501	Gas production	Offshore Cook Inlet.
Standard Oil Co. of California.	do	do	Westside Cook Inlet.
Texaco, Inc	do	do	Do.
Union Oil Co. of California.	do	do	Offshore Cook Inlet, Kenai Peninsula.
Petroleum—crude:			
Amoco Production Co	do	Oil production	Offshore Cook Inlet, Kenai Peninsula, Offshore Cook Inlet, North Slope.
Atlantic Richfield Co	do	do	North Slope.
BP Alaska, Inc	do	do	Kenai Peninsula.
Marathon Oil Co	do	do	Offshore Cook Inlet.
Mobil Oil Corp	do	do	Do.
Shell Oil Co	do	do	Kenai Peninsula.
Standard Oil Co. of California.	do	do	Do.
Texaco, Inc	do	do	Do.
Union Oil Co. of California.	do	do	Do.
Petroleum refining:			
Atlantic Richfield Co	Prudhoe Bay, Alaska	Refinery	North Slope.
Standard Oil Co. of California.	Nikiski, Alaska	do	Kenai Peninsula.
Tesoro-Alaskan Petroleum Corp.	do	do	Do.
Union Oil Co. of California.	Anchorage, Alaska 99501	Refinery (asphalt)	Anchorage.

Table 5.—Alaska: 1976 Annual production

		Total	
		Quantity	Per day
Oil	barrels	67,008,789	183,084
Water	do	20,982,895	57,330
Casinghead gas	thousand cubic feet	355,196	9,705
Dry gas	do	402,430	10,995
Condensate	barrels	547	2
Natural gas liquids	do	769,765	2,103

Source: State of Alaska Department of Natural Resources, Division of Oil and Gas Conservation Annual Report, 1976.

cilities were installed for unloading modules and other plant equipment.

The Department of the Interior selected 3.2 million acres of OCS area in the western Gulf of Alaska for a proposed lease sale. The total area is 220 miles long and 60 miles wide. The Interior Department also proposed a lease sale in lower Cook Inlet scheduled for early in 1977. In November 1976, Interior Secretary Kleppe revised the Department's leasing schedule and cancelled all future 1977 sales. These changes came in response to Governor Hammond's request for major revisions in the OCS sale schedule. Details covering future sales will be available early in 1977.

Pacific Gas and Electric Co. (PG&E) of San Francisco, Calif., and Pacific Lighting Corp. (PLC) of Los Angeles, Calif., announced plans to transport liquid natural gas from Alaska to the West Coast. The project will cost about \$1.2 billion and could supply 20 million cubic feet per day (MMcfd) initially peaking to 40 MMcfd. A gathering system and liquifaction plant will be constructed at Kenai and a regasification plant will be built at Los Angeles.

The jack-up rig George Ferris continued to be an extremely controversial element in Alaska in 1976. Approximately \$6 million in repairs were made on the rig as a result of the damages sustained the previous year. After repairs were completed attempts were made to move the rig to a location in Cook Inlet. The legs of the rig were mired in about 80 feet of muck, and it could not be moved. Salvage crews freed the rig by cutting off the legs with blasting agents, allowing the rig to be towed away. Minimal environmental damage occurred in Kachemak Bay during the salvage operations.

Nikiski Alaska Pipeline Co. completed a 180-mile, 10-inch product pipeline from Nikiski to Anchorage. The line is designed to carry 50,000 barrels per day of refined petroleum products from the Tesoro-Alas-

kan Petroleum Corp. refinery at Kenai to the terminal tank facility at Anchorage. The line cost about \$21 million.

The first exploration well drilled in Cook Inlet since 1974 was plugged and abandoned. Pan American Petroleum Corp. drilled a well in 1968 and discovered the

Redoubt Shoal oilfield. Reserves were limited and did not warrant construction of an offshore production platform. Union Oil Co. of California drilled the exploration well in 1976 to prove up additional reserves.

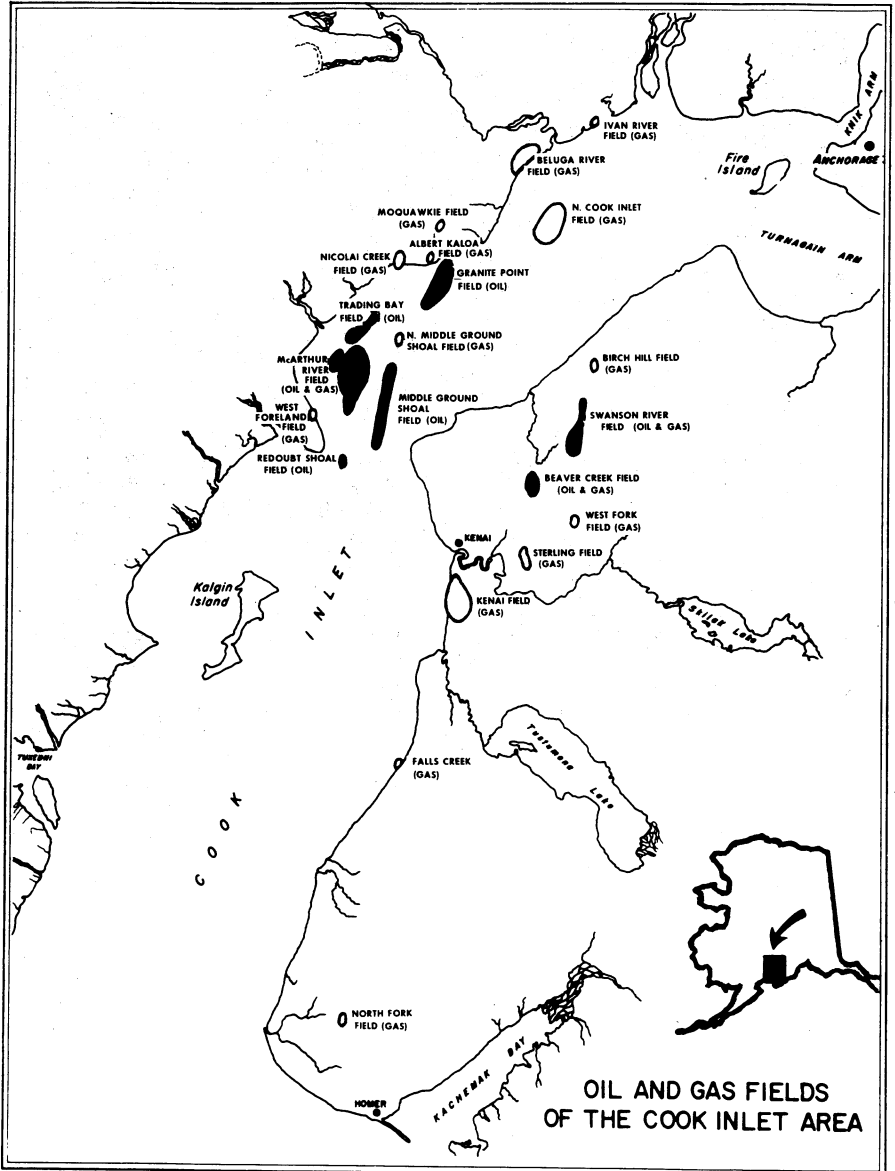


Figure 3.—Cook Inlet oilfields and gasfields.

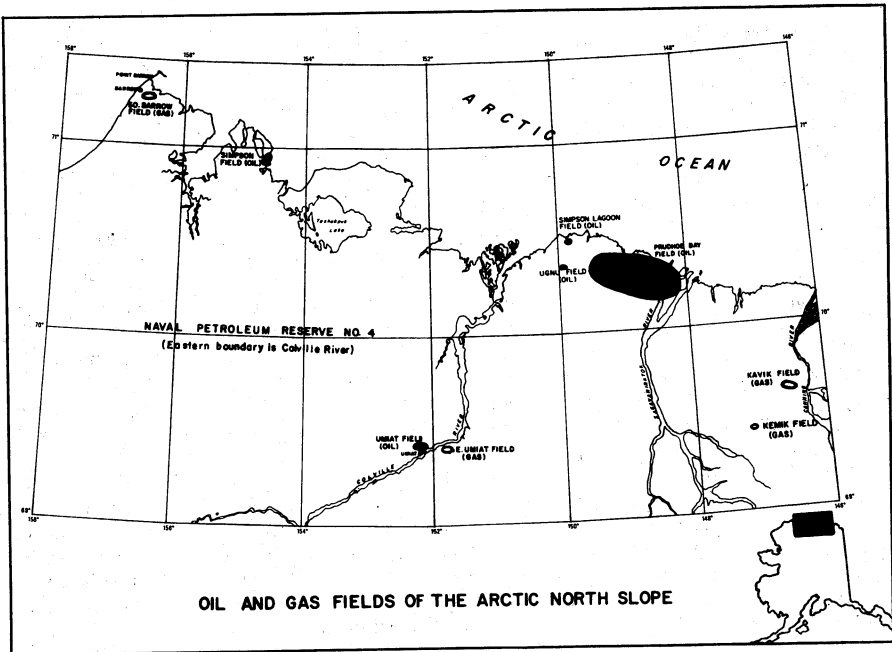


Figure 4.—Oilfields and gasfields of the Arctic North Slope.

Phillips Petroleum Co. started drilling an exploration well about 60 miles east of Port Moller on the Alaska Peninsula. The wildcat is being drilled under an exploration agreement with the Bristol Bay Native Corp.

Oil exploration in the Gulf of Alaska started in September at location Maria near Yakutat. The semisubmersible rig *Sedco 706* spudded in the first well for Arco, Shell, and Texas Eastern and Offshore Development. Arco also is moving the *Ocean Ranger* from the Bering Sea to the Gulf of Alaska to drill a second exploratory hole. There are three more semisubmersible rigs scheduled for the Gulf by 1977. The *Sedco 708*, *Aleutian Key*, and the *Alaskan Star* are all expected to be in operation early in 1977.

The *Sedco 706* left San Francisco for Alaska in August and started drilling in September. There are 10 units in the *Sedco 706* series, and operations with rigs over the past 3 years in the upper North Sea have proved the capability of these types of rigs to function safely in the Gulf of Alaska. The rig was leased to Arco, Shell, and Mobil Oil Co. and will be serviced from

Yakutat which will be developed as a base for other Gulf of Alaska operations.

Exxon christened the *Alaskan Star* at Hiroshima, Japan, in December. The semisubmersible rig will join two other rigs in the Gulf of Alaska early in 1977. Crews will be trained aboard the new vessel when it arrives in Seward. There are three more semisubmersible rigs scheduled to join those already in the Gulf by the spring of 1977. *Sedco 708* will be drilling for Sun Oil Co., the *Aleutian Key* for Gulf Oil Co., and a second rig which is presently under construction will be drilling for Exxon.

Seward is expanding rapidly as a result of offshore activity in the Gulf. Three major service companies proposed building facilities in the city, and others are proposing construction of dock facilities to handle the large supply boats that will be used to service the semisubmersible rigs in the Gulf of Alaska. Exxon has leased about 30 acres for storage, and supplies will move through the Alaska Railroad docks to supply boats.

The Office of Naval Petroleum and Oil Shale Reserves, Department of the Navy, continued the exploration program started

on Naval Petroleum Reserve No. 4 (PET-4) in 1975. The first exploratory well was completed and plugged as a dry hole. A second well was spudded near Harrison Bay late in 1976; it will be completed in 1977. Locations were set for four additional wells to be drilled during the winter season. Barrow No. 13 was being drilled in an attempt to provide additional gas reserves for Barrow Utilities, Inc.

The last section of 48-inch pipe for the trans-Alaska oil pipeline was placed at Thompson Pass, northeast of Valdez, late in 1976. Construction on pump stations, related facilities, and the Valdez terminal was about 80% complete and Alyeska expects a startup in the fall of 1977. Design modifications increased the final length of the line to 801 miles from the original 798 miles. Initial plans call for a throughput of 600,000 barrels per day, increasing to 1.2 million, with a possible maximum of 2.5 million barrels per day. North Slope petroleum reserves were estimated at 9.6 billion barrels and gas reserves at 260.2 million cubic feet.

Shiploading capacity at the Valdez terminal is 80,000 to 110,000 barrels per hour. Terminal facilities include two tank farms, docks, loading and ballast water treatment areas, a vapor recovery plant, oil spill contingency equipment, and a pipeline control center. There will be 18 storage tanks, each with a capacity of 510,000 barrels initially. Additional tanks will be constructed as the pipeline throughput reaches the capacity of 2 million barrels per day.

All operations of the pipeline will be regulated from a control center at the Valdez terminal. The system will include a master station at Valdez and a remote station at each of the 12 pump stations. Communications will be by microwave with a satellite backup system. There will be 41 permanent microwave stations between Valdez and Prudhoe Bay. The system parallels the pipeline and is tied in with all pump stations, remote controlled gate valves, and maintenance centers. An electronic system will monitor seismic activity near the pipeline and relay data to the control center and pump stations. Warning lights will flash at each location if there is any ground movement.

FPC is presently considering three competing pipelines to deliver natural gas from Prudhoe Bay to markets in the "lower 48."

An FPC recommendation to the President will be made in 1977 as specified in Public Law 94-586, Alaska Natural Gas Transportation Act of 1976.

The Alaskan Arctic Gas Pipeline Co. project involves the construction of about 3,600 miles of new 24-, 36-, and 48-inch pipeline and 875 miles of looped (connected and parallel to existing line), 36-inch pipeline. This pipeline would pick up U.S. natural gas in Prudhoe Bay and Canadian natural gas in the Mackenzie Delta and Northwest Territories. The route would extend about 400 miles eastward to the vicinity of Inuvik then south along the Mackenzie River to Caroline Junction, Alberta. Approximately 1,300 miles of new pipeline would be constructed in the United States while 1,400 miles would be constructed in Canada. The line would branch at Caroline Junction with the west leg extending to the Pacific Northwest and south to California. The east leg would enter Montana and extend southeastward to Illinois. Project facilities are designed to initially transport about 280 million cubic feet of natural gas per day to U.S. markets and will cost an estimated \$5.9 billion.

The El Paso Alaska Gas Co. proposed an 800-mile, 3.5-foot pipeline extending from Prudhoe Bay to Gravina Point near Valdez. The line will follow the existing trans-Alaska oil pipeline right-of-way for most of the 800 miles. A liquefaction plant, docking, and tanker loading facilities would be located at Gravina Point and liquefied natural gas (LNG) tankers would transport the gas to gasification plants at Point Conception, Calif. A fleet of 11 cryogenic tankers would transport LNG about 1,900 nautical miles to California. This project will cost an estimated \$6.54 billion and be capable of transporting 24 million cubic feet of gas daily.

Alcan Pipeline Co. and several other Canadian companies proposed building about 3,700 miles of new 36- and 48-inch pipeline and 1,700 miles of looped pipeline to deliver natural gas to western, midwestern, and eastern markets. The line would pick up Prudhoe Bay natural gas and follow the trans-Alaska oil pipeline route to Delta Junction. From there it would parallel the Alcan Highway to connect with Canadian pipelines in British Columbia and Alberta. The gas would then be shipped by existing pipelines to western United States markets.

Gas would also go to eastern market by displacement. This system would have a capacity of about 240 million cubic feet per day at a cost of about \$628 billion.

METALS

Antimony.—A very small quantity of antimony was produced in 1976. Most of the production came from the Tok River area in south-central Alaska. Minor amounts also were produced in the Fairbanks and Kantishna areas. Prospecting for gold, silver, lead, and antimony continued on Eldorado and Caribou Creeks in the Kantishna area, Mount McKinley recording district.

Copper.—There was no copper production in 1976, but it is still one of the most actively sought metals on the Alaskan scene. Considerable exploration activity continued in the Brooks Range, particularly the Ambler River, Survey Pass, and De Long Mountains areas. Bear Creek Mining Co. continued exploration efforts to extend the large disseminated copper-lead-zinc deposit at its Arctic camp prospect just north of Kennecott's bornite holdings. The Anaconda Company and Sunshine Mining Co. continued drilling a large disseminated copper-lead-zinc deposit in the Ambler area, and Noranda Mines, Ltd. had exploration crews in the Ambler River and Survey Pass areas. General Crude Oil Co., BP Alaska Exploration, Union Carbide Corp., United States Steel Corp., Placid Oil Co., and McIntyre Mines Ltd. also were active in the Brooks Range region.

Activity in the eastern Alaska Range between the Canadian border and the Gakona River continued through the 1976 season. Chisana-Horsfeld, Nabesna-Orange Hill, and the Slana areas received the most attention. Inspiration Development Co., Brown and Root Explorations, Gulf Min-

erals Exploration, ASARCO Inc., Rio Tinto Canadian Exploration, and Louisiana Land and Development Corp. were all active in the area. Inspiration Consolidated Copper Co. continued to extend the reserves of a copper-nickel property on Yakobi Island in southeast Alaska.

Chromite.—Union Carbide Corp. mined chromite from deposits at Red Mountain, 10 miles east of Seldovia in the Kenai Mountains from 1942 to 1944. The Kenai Chrome Co. took over the operation and produced more than 18,000 tons of ore from 1954 to 1957. About 8,000 tons of this ore and concentrate was stockpiled on the beach near Seldovia. Englehard Minerals & Chemicals Corp. purchased the chrome from the Federal Government about 5 years ago. Englehard sold the chrome to Japan and moved it by barge to an ore carrier in Kasitna Bay in July.

Gold.—Alaskan gold production increased 53% during 1976, due mainly to the operation of two dredges in the Nome area. There were 22,887 troy ounces of gold produced in 1976 compared with 14,980 produced in 1975. Value of the 1976 production was \$2.9 million. Many miners do not report their production, therefore the total may be misleading.

Northgate Exploration Ltd. and Westfield Minerals Ltd. jointly hold interest in Westpark Exploration Ltd., a U.S. firm, which completed an offshore and onshore drilling and sampling program at Daniels Creek between Solomon and Golovin on the Seward Peninsula. Assays of samples were encouraging but the total yardage that could be developed on the property was not large enough to permit mining.

Alaska Gold Co. reactivated dredge No. 6 near the Nome airport and continued operating dredge No. 5 during the 1971 season. Dredge No. 5 started up in May and

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
1972 -----	25	902	8,639	\$506	\$0.561
1973 -----	23	972	7,107	695	.715
1974 -----	21	975	9,146	1,461	1.498
1975 -----	23	1,751	14,980	2,419	1.381
1976 -----	26	1,699	22,605	2,833	1.667

¹ Excludes material treated primarily for the recovery of platinum.

No. 6 started up in September 1976. No. 5 was shut down for 3 weeks to replace the bucket-line and buckets. Alaska Gold Co. did not operate its dredge on the Hogatza River. Bliss and Sons continued operating on the Ungalik River east of Nome. The Alaska Department of Fish and Game denied Bliss and Sons an operating permit for 1977.

More than 75 placer miners were notified of adjudicatory hearings on National Pollutant Discharge Elimination System (NPDES) Permits. Preliminary hearings planned for December 1976 were delayed until early 1977. Gil Zemansky, formerly of Fairbanks, claimed EPA discharge standards were too lenient and asked for hearings to clarify the issue. The Alaska Miners Association formed a placer miners committee to represent the placer mining industry in this and similar incidents.

Placer gold production was reported in the Circle-Center district, Coal Creek, Manley Hot Springs, Fortymile, Boundary, Wisemen, Ruby, Flat, and Marble Creek areas. There also was activity in the Kougarok and Candle areas on the Seward Peninsula. Several placer mines were operating in the Kantishna district and a lode gold mine was operating near Willow. Four Bears Enterprises continued its exploration program at the Bartholomae mine at Easter, west of Fairbanks. Callahan Mining Corp. continued underground exploration at the Little Squaw mine, Chandalar district. This work was started in 1974 when a 9- to 15-foot-wide vein assaying more than 2 ounces per ton was found.

Alaska Mineral and Exploration Ltd., Inc., built a \$225,000 mining machine designed to dredge the gold sand beaches offshore Nome. This four-wheeled vehicle is capable of operating up to 100 feet from shore in water depths of 20 to 40 feet. The designers say the vehicle can dredge up to 200 cubic yards per hour; operating costs will be about \$1.90 per cubic yard.

Molybdenum.—United States Borax & Chemical Corp. confirmed a molybdenum discovery 45 miles east of Ketchikan. The announcement came after an extensive exploration and drilling program conducted over the past 5 years. Preliminary drilling indicated a deposit in excess of 120 million tons. Most of this is near the surface and it is suitable for open pit mining.

United States Borax applied for U.S. Forest Service permits to construct an access road to the mine site at Quartz Hill. Several routes are being considered and a draft EIS is expected early in 1977. Preliminary planning includes a 6,000-ton-per-day concentrating plant, a dock, and other support facilities at an estimated cost of \$250 million. If the project is feasible, it would employ about 1,000 people during the construction phase and about 500 workers on a fulltime production basis. Ketchikan would be the primary supply base for the mine.

Nickel.—Inspiration Consolidated Copper Co. continued its exploration drilling program to delineate a nickel-copper deposit on Yakobi Island in southeast Alaska. Newmont Mining Corp., Cities Service Corp., and Union Pacific Minerals Corp., have postponed indefinitely any further activity on their nickel-copper deposit in Glacier Bay National Monument.

Platinum.—There were small amounts of platinum produced at gold placer operations in 1976. Goodnews Bay Mining Co. closed its placer dredging operation on the Salmon River near Platinium.

Silver.—Exploration for silver and associated metals continued at about the same pace as in 1975. Activity in the Kantishna area, Mount McKinley district remained about the same. Exploration activity in southeast Alaska increased due to announcements of several discoveries in the area. Activity in Arctic Alaska and the Seward Peninsula increased considerably over that of 1975.

Tin.—Exploration drilling of a lode tin deposit on the Purkeypyle property continued at about the same level as 1975. This potential mine is within the boundaries of the proposed south extension of Mount McKinley Park. Small amounts of tin also were produced at Tin City near Wales on the northwest coast of Alaska.

Uranium.⁴—There was a significant increase in exploration for uranium in 1976. The U.S. Geological Survey announced the presence of uranium, thorium, and rare-earth elements concentrations on the southeast coast of the Seward Peninsula. Widespread intrusive rocks with above-average uranium-thorium values and the occurrence

⁴ Prepared by Conwell, C. Mining Engineer, Alaska Division of Geological and Geophysical Surveys.

of several uranium prospects were reported. The intrusive rocks are primarily monzonite and syenite but include both nepheline syenite and quartz monzonite. Exxon Co. and Cotter Corp. were active in southeast Alaska. Cotter plans a drilling program centered around the Old Bokan Mountain mine near Kendrick Bay on Prince of Wales Island.

WGM, Inc., a minerals consulting firm in Anchorage, was awarded a contract by the U.S. Energy Research and Development Administration (ERDA) for geological evaluations of the Cook Inlet and Susitna Basin areas in south-central Alaska. This is part of a nationwide ERDA program to locate additional sources of uranium. The Alaska Division of Geological and Geophysical Surveys also is investigating the uranium potential in Alaska as part of the long-range goal to locate and assess all mineral and energy resources in Alaska.

NONMETALS

Barite.—Chromalloy Mining, a subsidiary of Chromalloy American Corp., Houston, Tex., continued to produce barite from its mine near Petersburg in southeast Alaska. Chromalloy did not ship any crude ore in 1976. All production was crushed, pulverized, and sacked for Alaskan markets. A second barite deposit is being developed in southeast Alaska. Reports indicate the barite-lead-silver deposit near Haines is sizeable. Access roads have been constructed to the property which is conveniently located to future offshore drilling activity in the Gulf of Alaska.

Fluorite.—Lost River Mining Corp. continued its efforts to develop a fluorite-tungsten deposit at Lost River on the Seward Peninsula. The company applied to the U.S. Army Corps of Engineers for permits to construct two outfall lines at the mine site.

Sand and Gravel.—Production of sand and gravel in Alaska increased by about 26 million tons in 1976 due primarily to construction on the trans-Alaska oil pipeline and uptrends in other construction sectors. This trend is expected to continue until all pipeline activity is completed. Consumption of sand and gravel for general highway construction, building, and for airport use continued to increase in 1976. There were approximately 75 million tons of sand and gravel used in Alaska in 1976 compared with about 48 million tons in 1975.

Anchorage Sand and Gravel, the largest sand and gravel company in Alaska, opened a new pit about 35 miles north of Anchorage near Palmer. Sand and gravel has been increasingly difficult to obtain within the municipality of Anchorage; operating restrictions have become more stringent, forcing the company to move to assure an adequate supply to meet the increasing demand. The deposit is in the Talkeetna foothills, about 1 mile west of the railroad. It is expected to produce about 2 million tons per year for 14 to 16 years. Material is moved from the mine site to a loading station on the rail siding by two 1,500-foot-long, 3-foot-wide conveyor belts. The belts deliver about 1,800 short tons of material per hour to the rail siding. An 85-ton rail car can be loaded in less than 1 minute. Pit-run material is hauled by rail to Anchorage Sand and Gravel's facilities in the municipality of Anchorage. During the construction season, a 70- to 80-car train run is made 6 days per week. Capacity per train is about 6,500 tons.

Stone.—Production of stone declined about 24% from that of 1975. About 6.7 million tons was produced in 1976, valued at about \$20 million. Most of the stone production was used as riprap or for fill.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	Region
Barite: Chromalloy American Corp.	Box 650 Petersburg, Alaska 99833	Open pit -----	Southeastern Alaska.
Coal: Usibelli Coal Mining Co.	Box 3018 Fairbanks, Alaska 99701	----do -----	Yukon River.
Gold:			
Bliss and Sons -----	129 East 11th Ave. Anchorage, Alaska 99501	Placer-dredge ----	Northwestern Alaska.
Engstrom and Son Dredging Co.	Box 536 Nome, Alaska 99762	----do -----	Seward Peninsula.
Heflinger Mining and Equipment Co.	409 Clara St. Fairbanks, Alaska 99701	Placer -----	Yukon River.
Little Squaw Gold Mining Co.	Box 184 Spokane, Wash. 99210	Lode-placer -----	Do.
Marvel Creek Mining Co. --	Nyak, Alaska 99642 -----	Placer-dredge -----	Kuskowim River.
Miscovich Mining Co. -----	Box 23 McGrath, Alaska 99627	Hydraulic -----	Do.
Peters Creek Mines -----	700 Ash Pl. Anchorage, Alaska 99501	Placer -----	Cook Inlet- Susitna.
UV Industries, Inc. -----	437 Madison Ave. New York, N.Y. 10022	Placer-dredge -----	Seward Peninsula.
Sand and gravel:			
Alaska Brick Co. -----	7800 Lake Otis Rd. Anchorage, Alaska 99507	Pit -----	Do.
Alaska General Sand and Gravel.	Lake Otis Rd. Anchorage, Alaska 99507	Pit -----	Do.
Alaska Sand and Gravel, Inc.	University Ave. Fairbanks, Alaska 99707	Pit -----	Yukon River.
Anchorage Sand and Gravel.	1813 East 1st Ave. Anchorage, Alaska 99501	Pit -----	Cook Inlet- Susitna.
Baugh-Belarde -----	1848 Ship Ave. Anchorage, Alaska 99501	Pit -----	Do.
Castle Construction Co. ----	8121 Sand Lake Rd. Anchorage, Alaska 99502	Pit -----	Do.
Central Construction Co., Inc. ¹	428-117 2d Ave. Seattle, Wash. 98101	Pit -----	Northwestern Alaska.
Green Associated -----	Pouch 85 Fairbanks, Alaska 99707	Pit -----	Southeastern Alaska.
Rogers and Babler Inc. ----	4607 East Tudor Rd. Anchorage, Alaska 99507	Pit -----	Cook Inlet- Susitna.
Vast Construction Co., Inc. -	Box 4-GG Anchorage, Alaska 99509	Pit -----	Do.
Stone:			
Burgess Construction Co. ---	394 Hamilton Fairbanks, Alaska 99707	Quarry -----	Yukon River, Southeast Alaska.
Ketchikan Pulp Co. -----	Box 1619 Ketchikan, Alaska 99901	----do -----	Southeastern Alaska.
Klatt Aggregate Inc. -----	Lake Otis Rd. Anchorage, Alaska 99502	----do -----	Cook Inlet- Susitna.
LOG Logging Co. -----	Cape Pole Ketchikan, Alaska 99901	----do -----	Southeastern Alaska.
Moore Construction Co., Inc.	Ketchikan, Alaska 99901 ---	----do -----	Do.
Wayne Construction Co. ----	4100 Tongass Ave. Ketchikan, Alaska 99901	----do -----	Do.
Welborn Construction Inc. --	Box 634 Kodiak, Alaska 99615	----do -----	Kodiak.
Tin:			
Lee Bros. Dredging Co., Inc.	Box 816 Nome, Alaska 99762	Dredge -----	Seward Peninsula.

¹ Also stone.

The Mineral Industry of Arizona

This chapter was prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Arizona Bureau of Mines for collecting information on all minerals.

By Joseph C. Arundale ¹

Arizona mineral output in 1976 reached a new record high of \$1.7 billion. Arizona ranked 10th among the States in value of minerals produced in 1976. Output of most major mineral commodities in Arizona was up in 1976, compared with the temporary downtrend in 1975.

Copper production exceeded 1 million tons, an alltime high, and its value accounted for about 83% of total mineral value in Arizona. Arizona continued its longstanding role as the Nation's leading producer of copper, accounting for 64% of the U.S. total. The State again ranked second in molybdenum output, second in silver, and fourth in gold; output of all these metals was up significantly in 1976.

The nonmetallics registered gains, particularly in sand and gravel, stone, and lime. Coal output expanded 49% and exceeded 10 million tons.

An active exploration program was conducted throughout the State for a variety of minerals. The minerals industry was confronted with a growing number and expanding variety of problems, including water supply and quality, environmental restrictions, accelerating costs, taxation, and land use regulations. Some of these problems were reaching the critical stage.

¹ State Liaison Officer, Bureau of Mines, Phoenix, Ariz.

Table 1.—Mineral production in Arizona¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos -----short tons..	1,676	W	W	W
Clays -----thousand short tons..	129	\$483	² 28	² \$361
Coal (bituminous) -----do..	6,986	W	10,420	W
Copper (recoverable content of ores, etc.) -----short tons..	813,211	1,044,162	1,024,421	1,425,994
Gem stones ----- Gold (recoverable content of ores, etc.) -----troy ounces..	NA	³ 5,000	NA	4,000
Gypsum -----thousand short tons..	85,790	13,854	102,062	12,790
Lead (recoverable content of ores, etc.) -----short tons..	117	419	139	529
Lime -----thousand short tons..	420	181	338	156
Mica, scrap -----do..	512	12,444	546	16,115
Molybdenum (content of concentrate) -----thousand pounds..	2	65	W	W
Natural gas -----million cubic feet..	25,030	61,411	31,073	89,148
Petroleum (crude) ..thousand 42-gallon barrels..	208	58	262	74
Pumice -----thousand short tons..	635	3,332	519	2,724
Sand and gravel -----do..	856	1,294	802	1,240
Silver (recoverable content of ores, etc.) -----thousand troy ounces..	17,222	36,490	⁴ 18,131	⁴ 40,134
Stone -----thousand short tons..	6,286	27,783	7,615	33,126
Zinc (recoverable content of ores, etc.) -----short tons..	3,404	11,030	4,147	13,921
Zinc (recoverable content of ores, etc.) -----short tons..	8,655	6,751	9,501	7,080
Value of items that cannot be disclosed:				
Beryllium concentrate (1976), cement, clays (ball clay and common clay, 1976), feldspar, fluorspar (1976), helium (high purity), iron ore, perlite, pyrite, salt, sand and gravel (industrial, 1976), tungsten, turquoise (1975), and values indicated by symbol W --				
	XX	63,666	XX	79,229
Total -----	XX	1,288,423	XX	1,726,621
Total 1967 constant dollars -----	XX	509,829	XX	^p 620,720

^p Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes ball clay and common clay; value included with "Value of items that cannot be disclosed."

³ Excludes turquoise; value included with "Value of items that cannot be disclosed."

⁴ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Arizona, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Apache -----	\$5,124	\$3,863	Petroleum, pumice, clays, sand and gravel, natural gas, helium.
Cochise -----	W	W	Copper, lime, stone, sand and gravel, silver, gold, lead.
Coconino -----	3,545	2,532	Sand and gravel, pumice, stone.
Gila -----	178,218	187,098	Copper, silver, molybdenum, gold, sand and gravel, asbestos, fluorspar, stone, lime, clays, lead.
Graham -----	908	1,021	Copper, sand and gravel, pumice.
Greenlee -----	W	W	Copper, silver, lime, gold, stone, sand and gravel.
Maricopa -----	21,454	20,491	Sand and gravel, lime, salt, mica, stone, clays.
Mohave -----	32,578	27,736	Copper, molybdenum, sand and gravel, silver, feldspar, stone, zinc, gold, lead.
Navajo -----	22,472	38,341	Coal, sand and gravel, iron ore, pumice, stone.
Pima -----	450,912	680,513	Copper, molybdenum, cement, silver, sand and gravel, stone, gold, lead, clays, zinc, tungsten, mica.
Pinal -----	297,750	401,327	Copper, molybdenum, silver, gold, stone, sand and gravel, lime, perlite, gypsum, pyrites, lead, zinc.
Santa Cruz -----	W	600	Sand and gravel, zinc, silver, lead, gold, copper.
Yavapai -----	57,598	67,506	Copper, cement, zinc, lime, sand and gravel, stone, molybdenum, silver, gypsum, clays, gold, lead.
Yuma -----	W	W	Sand and gravel, stone, lead, silver, zinc.
Undistributed ² -----	217,870	295,594	
Total ³ -----	1,288,423	1,726,621	

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

¹ Value of petroleum is based on an average price per barrel for the State.

² Includes value of mineral production 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 Arizona business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	877.0	947.0	+8.0
Unemployment -----do-----	82.6	93.0	+12.6
Employment (nonagricultural):			
Mining -----do-----	24.6	24.5	-.4
Manufacturing -----do-----	99.8	105.6	+5.8
Contract construction -----do-----	43.8	41.4	-5.5
Transportation and public utilities -----do-----	38.8	39.4	+1.5
Wholesale and retail trade -----do-----	175.8	183.4	+4.3
Finance, insurance, real estate -----do-----	42.2	42.6	+.9
Services -----do-----	134.4	143.8	+7.0
Government -----do-----	169.7	177.3	+4.5
Total nonagricultural employment -----do-----	729.1	758.0	+4.0
Personal income:			
Total -----millions--	\$11,819	\$13,166	+11.4
Per capita -----do-----	\$5,344	\$5,799	+8.5
Construction activity:			
Number of private and public residential units authorized -----do-----	18,504	23,963	+29.5
Value of nonresidential construction -----millions--	\$221.2	\$585.3	+164.6
Value of State road contract awards -----do-----	\$120.0	\$140.0	+16.7
Shipments of portland cement to and within the State -----thousand short tons--	1,086	1,111	+2.3
Mineral production value:			
Total crude mineral value -----millions--	\$1,288.4	\$1,726.6	+34.0
Value per capita, resident population -----do-----	\$582	\$761	+30.8
Value per square mile -----do-----	\$11,311	\$15,158	+34.0

^p Preliminary.

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

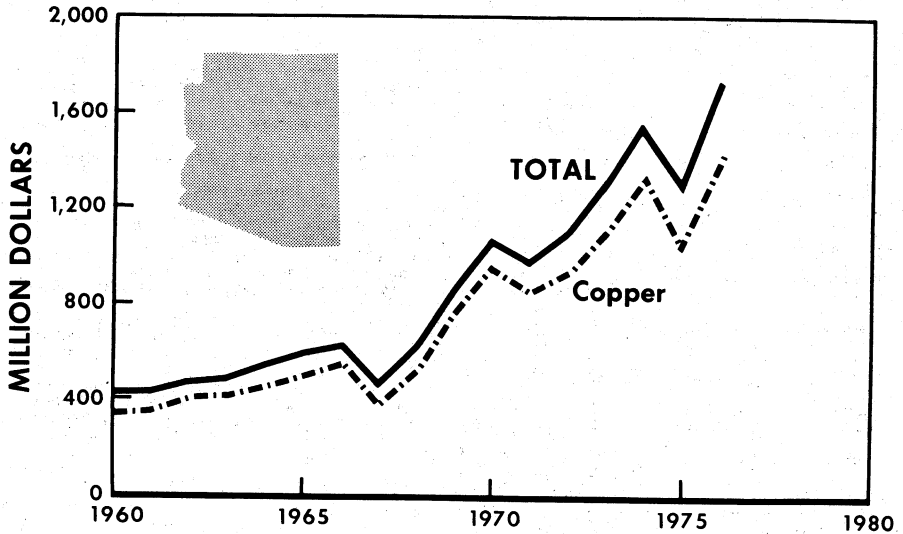


Figure 1.—Value of mine production of copper and total value of mineral production in Arizona.

Table 4.—Arizona: Major sources of income¹
(Millions)

Source of income	1975	1976	Change, percent
Manufacturing (value added) ---	\$1,950	\$2,140	+9.7
Mining ² -----	1,288	1,727	+34.1
Tourism -----	---	2,625	---
Livestock -----	505	541	+7.1
Crops -----	581	699	+20.3

¹ Valley National Bank Research Department, Phoenix, Ariz.

² U.S. Bureau of Mines.

Table 5.—Arizona: Valuation on centrally assessed groups of property¹
(Millions)

Group	1975	1976	Change, percent
Utilities -----	r \$780.4	\$813.7	+4.3
Mines -----	r 1,109.1	1,166.6	+5.2
Pipelines -----	344.0	312.3	-9.2
Railroads -----	146.6	140.1	-4.4
Airlines -----	27.5	30.1	+9.5
Oil and gas ---	3.5	3.0	-14.3

r Revised.

¹ Pay Dirt, June 28, 1976.

Trends and Developments.—Output of most major mineral commodities in Arizona was up in 1976, compared with the temporary downtrend in 1975 which reflected the general recession in the Nation's economy that year. Worldwide, the long-term trend in both production and consumption of copper has been upward. Discoveries, new developments, and expansions continued to add to overall production capacity for copper in Arizona. Improved domestic demand and higher prices during the first part of 1976 caused output of copper in Arizona to reach an alltime high. Arizona produced 64% of the Nation's copper during 1976. New production facilities brought onstream in 1976 included an underground mine and two electrowinning plants.

A report on the copper's impact on the Arizona economy in 1975² indicated that the copper industry "retained its traditional position as a major source of personal, business, and governmental income" despite production cutbacks and layoffs. The report calculated the copper industry's contributions to personal income in the State at

² Leaming, G. F. The Copper Industry's Impact on the Arizona Economy. Arizona Economic Information Center, September 1976, 40 pp.

\$360.2 million in direct payments to residents, mostly as wages and salaries. Almost \$388 million in income was provided by copper to other Arizona businesses. In 1975, the Arizona copper industry also paid more than \$103 million in property taxes, severance taxes, corporate income taxes, payroll taxes, sales taxes, motor vehicle licenses, rents, and royalties for use of State lands. According to the report, the combined impact of the copper industry on Arizona's economy in 1975 was "to provide, both directly and indirectly, more than \$5.1 billion in personal, business, and government income" or "46 times the amount that it took from the State."

The Navajo Tribal Chairman offered to share the tribe's mineral wealth with the State of Arizona in return for better medical facilities, more educational opportunities, and improved roads on the giant reservation in northeast Arizona.

The year 1976 began with substantial industry-held copper stocks on hand in the United States and other areas. In the first half of the year, sales volume and prices were rising, with demand reaching a peak in the second quarter. Much of the increased demand for copper products during the first half of the year was satisfied from

fabricators' inventories and increased copper imports. There was a decline in demand as well as prices in the second half, particularly in the last quarter.

Producer prices for refined copper rose early in 1976 but declined later in the year. The average price was 69.6 cents per pound, compared with an average of 64.2 cents for 1975, but a yearend quotation of 65 cents per pound carried over into 1977. U.S. consumption of refined copper was estimated at 2.0 million tons, a 30% increase from the depressed levels of 1975 but 9% below that of 1974. Net imports of copper were a larger component of supply as imports of unmanufactured copper rose from 324,000 tons in 1975 to over half a million tons in 1976, while exports declined from 234,000 tons to 172,000 tons in the same period.

Employment and Injuries.—Employment in the minerals industry in Arizona was fairly constant during the year at about 21,000 workers. Man-hours worked in the minerals industry totaled slightly over 42 million, compared with about 39 million in 1975. There was little change in the frequency rate of fatal injuries, but the non-fatal rate decreased slightly.

Table 6.—Arizona: Worktime and injury experience in the mineral industries¹

Year and industry	Men employed	Man-hours worked	Fatal injuries	Fatal frequency rate	Nonfatal disabling injuries	Nonfatal disabling frequency rate
1975:						
Copper:						
Underground -----	4,996	9,633,025	3	0.31	479	48.89
Surface -----	7,030	13,320,560	2	.15	266	19.97
Shops -----	93	33,360	--	--	1	--
Mills -----	5,187	9,630,528	1	.10	191	19.73
Subtotal -----	17,306	32,617,473	6	.18	937	28.42
Office -----	1,838	3,462,406	--	--	4	1.16
Total -----	19,144	36,079,879	6	.17	941	25.80
Other metals:						
Underground -----	58	27,771	--	--	--	--
Surface -----	8	2,172	--	--	--	--
Mills -----	13	4,724	--	--	--	--
Subtotal -----	79	34,667	--	--	--	--
Office -----	5	1,401	--	--	--	--
Total -----	84	36,068	--	--	--	--
Sand and gravel:						
Surface -----	1,034	1,132,147	3	2.65	10	8.33
Office -----	72	73,084	--	--	--	--
Total -----	1,106	1,205,231	3	2.49	10	8.30
Other nonmetals:						
Underground -----	7	6,337	--	--	--	--
Surface -----	197	262,550	--	--	7	26.66
Mills -----	8	8,620	--	--	--	--
Subtotal -----	212	277,507	--	--	7	25.22
Office -----	11	9,330	--	--	--	--
Total -----	223	287,337	--	--	7	24.36
Coal:						
Underground -----	--	--	--	--	--	--
Surface -----	350	742,480	--	--	27	36.36
Mills -----	33	63,626	--	--	--	--
Total -----	383	806,106	--	--	27	33.49
1976:						
Copper:						
Underground -----	4,772	9,469,514	3	0.32	452	47.31
Surface -----	5,912	12,580,588	2	.16	180	14.31
Shops -----	656	1,211,510	--	--	7	5.78
Mills -----	5,173	10,682,022	2	.19	189	17.69
Subtotal -----	16,513	33,943,634	7	.21	828	24.39
Office -----	1,926	3,655,723	--	--	3	.82
Total -----	18,439	37,599,357	7	.19	831	22.10
Other metals:						
Underground -----	73	32,053	--	--	--	--
Surface -----	9	2,675	--	--	--	--
Mills -----	7	2,232	--	--	--	--
Subtotal -----	89	36,960	--	--	--	--
Office -----	3	765	--	--	--	--
Total -----	92	37,725	--	--	--	--
Sand and gravel:						
Surface -----	1,080	1,445,708	--	--	9	6.23
Office -----	115	143,026	--	--	--	--
Total -----	1,195	1,588,734	--	--	9	5.66
Other nonmetals:						
Underground -----	30	11,881	--	--	1	84.17
Surface -----	197	239,663	--	--	7	29.21
Mills -----	24	29,475	--	--	1	33.93
Subtotal -----	251	281,019	--	--	9	32.03
Office -----	13	14,351	--	--	--	--
Total -----	264	295,370	--	--	9	30.47
Coal:						
Underground -----	--	--	--	--	--	--
Surface -----	632	1,273,417	1	.79	53	41.62
Shops -----	--	--	--	--	--	--
Mills -----	32	61,493	--	--	--	--
Subtotal -----	664	1,334,910	1	.75	53	39.70
Office -----	10	23,055	--	--	--	--
Total -----	674	1,357,965	1	.74	53	39.03

¹ All injuries and man-hours reported and in file will be tabulated, but when computing injury-frequency rates, only those injuries for which man-hours are reported and in file will be used. Source: Mining Enforcement and Safety Administration.

Legislation and Government Programs.—Arizona officials were seeking funds from the National Science Foundation to study the impact of Federal, State, and local regulations on the copper industry. The project would be coordinated by the Arizona Economic Planning and Development Office and conducted largely by State universities. Every aspect from exploration through manufacture of finished copper products would be included in the study, with special attention to such items as the accessibility of minerals on public lands and smelter emissions controls. The primary objective would be to aid public and private interests in developing regulations that would maximize social benefits while minimizing private costs.

A bill was introduced to establish a Bureau of Geology and Minerals Technology in place of the Arizona Bureau of Mines. Such a new bureau could improve financial assistance from the State and subsequently the services to the mineral concerned public.

Exploration, Geologic Studies, Mapping.—A study by the Arizona Bureau of Mines for the U.S. Geological Survey showed a favorable uranium potential in a 13,000-square-mile region that includes the Mogollon and Tonto Rims in east-central Arizona. Likelihood for uranium occurrences was said to be especially favorable under portions of the Fort Apache Indian Reservation. The purpose of the study was to develop data that could be used in planning exploration programs. Copies of the report are available from the University of Arizona.

Kerr-McGee Corp. and Rocky Mountain Energy Co. were exploring a 14-square-mile area in the Whetstone Mountains near Benson. According to the U.S. Forest Service, 15 exploratory holes were planned.

Duval Corp. and St. Joe Minerals Corp. drilled exploration holes in search of potash minerals in Apache County. Although the results have been confidential, potential resources of potash are believed to occur in that area.

The Arizona Department of Mineral Resources began a program of plotting its mines and minerals files on large-scale county maps. This effort included inventorying the extensive files in the Department's possession, assigning file numbers,

and then locating files by numbers on the maps. The system was expected to greatly improve availability, access, and usefulness of the file information. In addition, the Department's files were being microfilmed.

The Arizona Bureau of Mines published a resume of coal resources on Black Mesa in its publication "Fieldnotes." The coal resource could amount to as much as 21 billion tons.

Energy.—Calling it "the first such formal agreement signed between the Energy Research and Development Administration (ERDA) and any state," Governor Castro announced a 5-year agreement that requires the State to identify regional needs, skills, and resources in energy-related fields and then submit specific research proposals for funding and technical support.

The Arizona State Corporation Commission signed a certificate of environmental compatibility for the Palo Verde nuclear generating station proposed by a consortium of southwestern utilities. The first stage in the licensing procedure also got underway with hearings by the Atomic Safety and Licensing Board of the U.S. Nuclear Regulatory Commission which were expected to lead to a Federal decision on a construction permit for the \$2.8 billion Arizona Nuclear Power Project. The first of three reactors at the 3,810-megawatt powerplant were planned for completion by 1982, if permits are granted. Opponents of the project said they would attempt political action to halt the project.

Environment.—Concerns about environmental factors affecting the minerals industry continued to rise in priority; the economic consequences also continued to increase in significance and complexity.

Arizona copper companies indicated that smelter emission regulations proposed by the State Air Quality Control Division during 1976 were acceptable, but a long-standing controversy between the State and the Environmental Protection Agency (EPA) was not resolved. Proposed regulations established specific sulfur emission limits for each of the State's seven copper smelters and outlined requirements for air monitoring systems in the vicinity of smelters. The major problem in settling this 5-year controversy was between the State and the EPA, which had not responded to these new proposed regulations.

Five of Arizona's copper smelters requested a further extension of a State Health Department order exempting smelters from some air pollution regulations. Smelters encountered problems of sulfuric acid mist as installation of new equipment to meet pollution standards was nearing completion. The smelters indicated they should be able to complete modification of equipment to handle the mist problem if given time.

Phelps Dodge Corp. requested permission from the Air Pollution Control Board to reduce production as a means of obtaining sulfur oxide emission compliance. The company had spent \$19 million on control of particulates but could not justify an acid plant as demanded by EPA.

Water.—Court decisions regarding the legality of pumping and utilizing water in Arizona created serious questions about the future supply of water for copper mining operations in the State.

A State Supreme Court ruling that water cannot be taken out of the Santa Cruz valley south of Tucson could be crucial to the huge copper industry in an area where nearly one-half of Arizona's copper is pro-

duced. The Court decision resulted from a 1969 suit by Farmers' Investment Co. (FICO), claiming illegal depletion of water under an Arizona law which prohibits pumping water from one parcel of land to another if other landowners' supplies are reduced by the pumping. The decision said that "FICO need not wait for its farms to be devastated before applying for injunctive relief against unlawful acts."

Although water supplies are not yet at a critical stage in Arizona, the problem of sharing available supplies is approaching a crisis. The decision by the Arizona Supreme Court that the copper mines (and the City of Tucson) could not legally continue groundwater pumping practices in the Santa Cruz Valley, pointed up the urgent need for legislative action to assure at least equitable distribution of available supplies. Governor Castro asked the big water users in the State—the mining industry, agriculture, cities, and Indians—to help ease Arizona out of its water crisis by cooperating on compromise legislation they all could support in the next session of the Arizona legislature.

REVIEW BY MINERAL COMMODITIES

METALS

Metals accounted for about 90% of the total value of Arizona mineral production.

Copper.—Nearly 83% of the value of mineral output in Arizona in 1976 was represented by copper alone.

Table 7.—Arizona: Total value of mineral production in Arizona, and production and value of copper in Arizona and the United States

Year	Arizona			United States		Arizona	
	Total value of mineral production (thousands)	Copper production		Copper production		Percent of U.S. copper production	Percent of world copper production
		Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)		
1972 -----	\$1,091,004	908,612	\$930,419	1,664,840	\$1,704,796	54.6	12.4
1973 -----	1,304,988	927,271	1,103,453	1,717,940	2,044,346	54.0	11.8
1974 -----	1,562,234	858,783	1,327,678	1,597,002	2,468,964	53.3	10.7
1975 -----	1,288,423	813,211	1,044,162	1,413,366	1,814,763	57.5	10.6
1976 -----	1,726,621	1,024,421	1,425,994	1,605,586	2,234,975	63.8	12.5

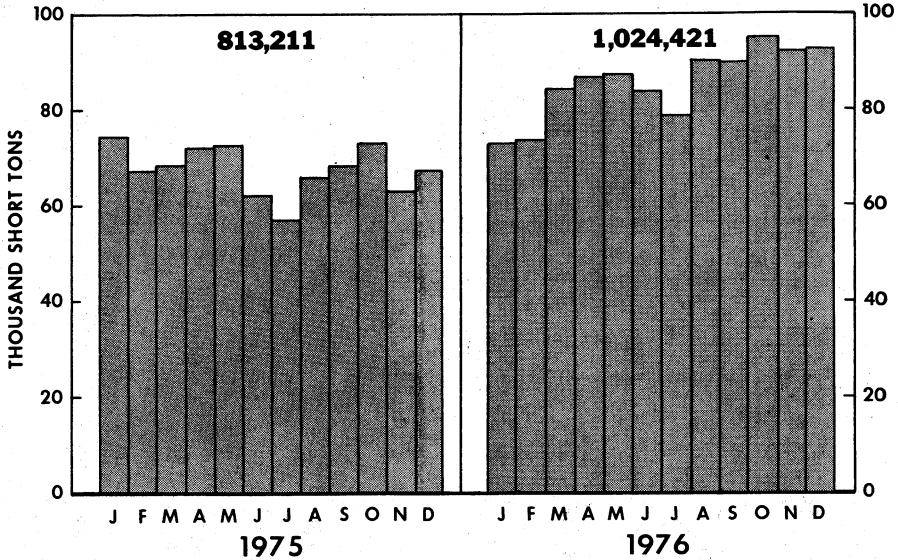


Figure 2.—Mine production of copper in Arizona, by month, in terms of recoverable metal.

Table 8.—Arizona: Fifteen leading copper-producing mines, in order of output

Rank in 1976	Rank in 1975	Mine	County	Operator	Source of copper in 1976
1	1	Morenci	Greenlee	Phelps Dodge Corp.	Copper ore, copper precipitates, copper tailings.
2	2	San Manuel	Pinal	Magma Copper Co.	Copper ore.
3	3	Sierrita	Pima	Duval Sierrita Corp.	Do.
4	16	Twin Buttes	do	Anamax Mining Co.	Do.
5	5	Ray	Pinal	Kennecott Copper Corp.	Copper ore and copper precipitates.
6	4	Pima	Pima	Cyprus Pima Mining Co.	Copper ore.
7	9	Metcalf	Greenlee	Phelps Dodge Corp.	Copper ore and copper tailings.
8	6	Pinto Valley	Gila	Cities Service Co.	Copper ore and copper precipitates.
9	10	New Cornelia	Pima	Phelps Dodge Corp.	Copper ore.
10	8	Superior (Magma)	Pinal	Magma Copper Co.	Do.
11	7	Inspiration	Gila	Inspiration Consolidated Copper Co.	Copper ore and copper precipitates.
12	11	Mission	Pima	ASARCO Incorporated.	Copper ore.
13	14	Silver Bell	do	do	Copper ore and copper precipitates.
14	12	Sacaton	Pinal	do	Copper ore.
15	13	Bagdad	Yavapai	Cyprus Bagdad Copper Co.	Do.

Table 9.—Arizona: Material handled and copper produced at fifteen leading copper mines

Mine	Ore mined (thousand short tons)		Waste material removed (ex- cluding material placed in leach dumps) (thousand short tons)		Material placed in leach dumps (thousand short tons)		Total copper produced ¹ (short tons)	
	1975	1976	1975	1976	1975	1976	1975	1976
	OPEN PIT							
Morenci -----	16,174	18,705	5,447	7,020	15,823	20,957	98,083	113,067
Sierrita -----	31,431	34,023	44,340	50,578	---	---	98,364	101,464
Twin Buttes -----	2,118	13,383	146,153	71,391	5,535	2,006	15,383	95,661
Ray -----	6,868	9,806	---	---	24,356	25,127	59,425	86,228
Pima -----	19,631	19,554	39,813	39,977	---	---	77,271	77,493
Metcalf -----	5,556	11,328	5,414	8,641	10,094	12,144	35,748	78,190
Pinto Valley -----	13,093	15,159	---	---	23,987	26,279	55,803	66,803
New Cornelia -----	7,270	9,482	6,860	6,699	4,045	3,995	33,495	51,016
Inspiration -----	6,297	4,610	10,409	3,633	7,139	5,209	44,897	35,935
Mission -----	5,090	6,407	7,578	9,763	---	---	26,946	35,190
Silver Bell -----	2,542	3,076	5,101	4,812	949	976	18,267	22,283
Sacaton -----	3,606	3,732	22,544	21,859	---	---	21,918	22,021
Bagdad -----	2,082	2,044	2,428	17,388	---	2,604	18,960	17,795
UNDERGROUND								
San Manuel -----	16,683	15,016	27	159	---	---	97,031	113,730
Superior (Magma) -----	956	971	135	150	---	---	40,398	41,446

¹ Gross metal content.² Recoverable content.

Table 10.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Lode mines produc- ing ¹	Material sold or treated (short tons)	Gold		Silver		Total value
			Troy ounces	Value	Troy ounces	Value	
			1974, total -----	48	179,095,757	90,586	
1976, total -----	39	169,244,487	85,790	13,854,229	6,285,854	27,783,475	
1976:							
Cochise -----	4	2,782,783	3,828	479,725	171,221	744,811	
Gila -----	9	30,166,602	9,219	1,155,328	461,523	2,007,625	
Greenlee -----	2	30,044,534	17,338	2,172,797	1,051,955	4,576,004	
Pima -----	9	90,023,951	25,246	3,163,829	4,096,166	17,818,322	
Pinal -----	9	35,337,840	45,812	5,741,159	1,521,426	6,618,204	
Santa Cruz -----	3	1,566	38	4,763	7,001	30,455	
Yavapai -----	4	2,136,377	523	65,543	102,132	444,275	
Undistributed ² -----	5	4,748,498	58	7,269	203,688	886,043	
Total ³ -----	45	195,242,151	102,062	12,790,411	7,615,112	33,125,739	
Copper							
		Short tons	Value	Lead		Zinc	
				Short tons	Value	Short tons	Value
1974, total -----	858,783	\$1,327,678,300	1,059	\$476,453	9,699	\$6,964,223	\$1,379,523,721
1976, total -----	813,211	1,044,162,368	420	180,587	8,655	6,751,054	1,092,731,713
1976:							
Cochise -----	8,942	12,447,905	(4)	189	---	---	13,672,630
Gila -----	128,762	179,236,159	(4)	33	---	---	182,399,143
Greenlee -----	184,563	256,912,067	---	---	---	---	263,660,868
Pima -----	399,308	555,836,434	264	121,748	24	17,711	576,958,044
Pinal -----	269,408	375,015,390	6	2,664	2	1,655	387,379,072
Santa Cruz -----	1	1,809	45	20,872	114	84,349	142,248
Yavapai -----	20,148	28,046,707	(3)	160	9,349	6,913,546	35,475,231
Undistributed ² -----	13,288	18,497,195	22	10,291	11	8,126	19,408,924
Total ³ -----	1,024,421	1,425,993,666	338	155,957	9,501	7,030,387	1,479,096,160

¹ Operations at miscellaneous cleanups not counted as mines.² Includes Graham, Mohave, and Yuma Counties combined to avoid disclosing company proprietary data.³ Data may not add to totals shown because of independent rounding.⁴ Less than 1/2 unit.

Table 11.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ¹	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold, gold-silver, and silver ² -----	10	993,177	3,860	289,065	25	2	--
Copper -----	27	194,046,281	97,636	7,276,850	953,447	280	86
Copper-zinc -----	1	90,278	325	31,545	2,768	--	9,349
Lead and lead-zinc ² -----	3	1,313	18	2,554	1	56	115
Total ³ -----	31	194,137,872	97,979	7,310,949	956,216	336	9,501
Other lode material:							
Gold-silver-tailings and copper tailings ² -----	3	⁴ 40,985	223	15,098	18,868	--	--
Copper precipitates -----	11	70,117	--	--	49,313	--	--
Total ³ -----	14	111,102	223	15,098	68,180	--	--
Grand total ³ -----	45	195,242,151	102,062	7,615,112	1,024,421	338	9,501

¹ Detail will not add to total because some mines produce more than one class of material.

² Combined to avoid disclosing company proprietary data.

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

⁴ Excludes newly generated tailings.

Table 12.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Cyanidation -----	3,661	125,000	--	--	--
Acid leaching (vat, tank, heap) ¹ -----	--	--	124,939	--	--
Smelting of concentrates -----	97,936	7,309,435	830,548	335	9,501
Direct smelting of—					
Ore -----	242	165,579	754	3	--
Precipitates -----	--	--	49,313	--	--
Tailings -----	223	15,098	18,868	--	--
Total -----	465	180,677	68,935	3	--
Grand total -----	102,062	7,615,112	² 1,024,421	338	9,501

¹ Includes copper recovered by electrowinning process.

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

After 6 years and expenditure of \$200 million, Hecla Mining Co. produced the first copper from its new underground mine 30 miles south of Casa Grande. Hecla, joint owner of the project with El Paso Natural Gas Co., expected the mine would be in full production by the end of 1976 with a goal of 67,000 tons of copper annually. However, the mine encountered technical problems that slowed this schedule. The mine is on the Papago Indian Reservation and royalties go to the tribe. The mine produces both sulfide and oxide ores. Copper from the sulfide ore is recovered in an electrolytic process. The oxide ores are processed to cement copper and pelletized for shipment to other smelters.

The Anaconda Company was merged into a wholly owned subsidiary of Atlantic Richfield Co., which had previously acquired a large bloc of Anaconda common stock.

Anamax Mining Co., a partnership in which The Anaconda Company and a subsidiary of AMAX, Inc., each have a 50% interest, operated the Twin Buttes open pit mine in Pima County. This mine produces both oxide and sulfide ores. Sulfide ore is concentrated and shipped to other locations for smelting into anode copper. Oxide ore is processed into cathode copper in an adjacent leaching and electrowinning plant.

During 1976 Anamax completed process changes and new equipment installation at its Twin Buttes property and resumed operations at the first of the year. The company was working out difficulties encountered in its agitation leaching-electrowinning plant completed in 1975.

ASARCO Incorporated and Anamax announced formation of the Eisenhower Mining Co. to mine the Palo Verde property. This property is between ASARCO's San Xavier South open pit and its Mission unit. One ore body underlies all the area, but diverse ownership had made it difficult to develop the entire ore body until agreement between all parties. Part of the ore will be milled at existing concentrators at ASARCO's Mission unit. Anamax planned to install a crusher at the mine and transport ore to Twin Buttes on a 6.5-mile conveyor system. The ore body contains an estimated 125 million tons averaging 0.6% copper.

Continental Oil Co. (Conoco) announced its decision to shelve indefinitely plans for

developing a large copper deposit near Florence. The deposit contains an estimated 800 million tons of ore with a grade of 0.40% to 0.45% copper. Oxide ores overlie sulfide ore under about 350 feet of overburden. Conoco had spent \$30 million in land acquisition, exploration, engineering design, environmental studies, and marketing research. After looking at such factors as escalating development costs, discouraging predictions of copper demand and prices, and problems in negotiating agreements with nearby users of groundwater, the company decided not to proceed.

Ranchers Exploration and Development Corp. produced cathode copper at its Bluebird open pit mine near Miami. The company uses heap leaching and a solvent extraction—electrowinning process (SX-EW process) that operates in three steps. In the first step, an organic mixture attracts and concentrates the ore in leach solutions produced by heap leaching. The organic mixture containing the copper is then separated from the leach solution and mixed with a high-strength sulfuric acid solution, which strips the copper from the organic mixture. The acid solution containing the concentrated copper then flows directly into the electrowinning plant where it is circulated through cells containing thin copper starting sheets. Electric current is passed through the copper-bearing solution, causing copper to be deposited on the copper starter sheets. These sheets gradually thicken to form cathodes weighing approximately 150 pounds. The company estimated that the Bluebird deposit contains approximately 65 million tons of drill-indicated reserves at an average grade of about 0.50% copper.

Occidental Minerals Corp. applied to the city of Miami for a permit to use liquid explosive to fracture copper-bearing zone 1,900 feet below the surface. The copper would be leached by sulfuric acid introduced through a drill hole, and pregnant solutions would be recovered from nearby holes.

Discovery of a large copper occurrence in central Arizona was announced by a joint venture of Hanna Mining Co. and Getty Oil Co. Preliminary reports indicated a deposit of 250 million tons of material averaging about 1% copper at depths below 1,600 feet. The preliminary indications were not yet adequate to assess the commercial

possibilities of the discovery. However, it was believed that conventional mining and metallurgical processes probably could be applied. A decision on production probably cannot be made for several years.

Gold.—Production of gold, largely as a byproduct of copper production, increased, but total value declined from that of 1975.

Molybdenum.—Output of molybdenum as a byproduct followed the increase in production of copper. The State ranked second in the Nation in molybdenum output.

Silver.—Recovered as a byproduct of copper production, silver output rose to the highest level in several years—7.6 million ounces.

Zinc.—Output of zinc increased 10% during 1976. Most of the zinc came from the Cyprus Bruce mine in Yavapai County, but the reserves in this mine were reported nearing exhaustion.

NONMETALS

Production of major nonmetallic minerals in the State was up from that of 1975.

Asbestos.—Jaquays Mining Corp. continued to produce chrysotile asbestos in Gila County.

Cement.—Two companies produced all the cement in the State in 1976: Arizona Portland Cement Co., a division of California Portland Cement Co., with a plant at Rillito in Pima County near Tucson, and Phoenix Cement Co., a division of Amcord, Inc., operating a plant at Clarkdale in Yavapai County. The cement industry operated at about the same level as in 1975,

but by yearend, demand was beginning to build up.

Lime.—Because of the use of lime in copper ore processing, the lime industry in the State increased output to meet the expanded demands of the copper industry. Lime was also used for sugar refining, for soil stabilization, in pulp and paper manufacturing, in water treatment, and in neutralizing acids.

Mica.—Scrap and flake mica was produced at the Buckeye mine in Maricopa County and the San Antonio mine in Pima County. The material was ground and sold for use in roofing materials, well-drilling fluids, and paint.

Perlite.—Output of perlite was down slightly from that of 1975, but the State was still a major producer. Three companies mined perlite in Pinal County: Guzman Construction Co., Filters International, Inc., and Harborlite Corp. The mined material was crushed and sized for use in filtering, or expanded and used as a lightweight aggregate.

Pumice and Volcanic cinder.—Output of volcanic cinders and pumice was down but continued as a substantial industry in several parts of the State.

Sand and Gravel.—Production of sand and gravel increased over that of 1975. After copper and its byproduct molybdenum, sand and gravel had the highest total value—\$40.2 million—of mineral commodities produced in Arizona. Unit value of sand and gravel in 1976 was up to about \$2.22 per ton, compared with \$2.12 per ton in 1975.

Table 13.—Arizona: Construction sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value ¹
Construction:				
Processed:				
Sand	5,049	11,512	4,913	12,207
Gravel	10,478	22,146	11,476	25,815
Unprocessed sand and gravel	1,694	1,640	1,741	1,643
Total ²	17,222	35,298	18,131	39,165

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant of blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

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

Table 14.—Arizona: Construction aggregate (blended sand and gravel) and industrial sand and gravel sold or used commercially by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential (1975)				
construction -----	4,170	10,184	4,037	10,388
Highway and bridge construction -----	327	749	155	469
Other construction (dams, waterworks, airports, etc.) -----	343	1,016	367	1,227
Concrete products (cement blocks, brick, pipe, etc.) -----	1,441	3,896	790	2,269
Bituminous paving (asphalt and tar paving) -----	1,602	2,893	1,695	3,502
Roadbase and subbase -----	3,472	6,636	3,498	7,265
Fill -----	624	1,429	775	1,786
Other -----	196	436	378	551
Unprocessed:				
Roadbase and subbase -----	504	342	572	400
Fill -----	625	764	571	668
Other -----	9	17	15	29
Industrial sand and gravel -----	W	W	W	W
Total ¹ -----	13,314	28,363	12,853	28,604

W Withheld to avoid disclosing company proprietary data; included with "Nonresidential and residential construction" in 1975; excluded from "Total" in 1976.

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

Table 15.—Arizona: Construction aggregate (blended sand and gravel) sold or used for publicly funded projects by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential construction -----	318	573	220	692
Highway and bridge construction -----	210	537	1,175	3,453
Other construction (dams, waterworks, airports, etc.) -----	W	W	12	23
Concrete products (cement blocks, brick, pipe, etc.) -----	W	W	147	566
Bituminous paving (asphalt and tar paving) -----	1,603	3,887	1,321	3,066
Roadbase and subbase -----	1,134	2,267	1,356	2,574
Fill -----	86	117	458	643
Other -----	W	188	6	3
Unprocessed:				
Roadbase and subbase -----	458	513	371	440
Fill -----	96	46	110	31
Other -----	1	(¹)	103	28
Total ² -----	3,908	8,127	5,278	11,580

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

¹ Less than ½ unit.

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

Table 16.—Arizona: Stone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Cochise -----	4	540	2,048	3	569	2,217
Coconino -----	9	102	185	7	45	89
Gila -----	4	141	326	2	W	W
Graham -----	1	27	44	--	W	W
Greenlee -----	W	W	W	3	57	77
Maricopa ¹ -----	8	117	274	3	W	W
Mohave -----	W	W	W	2	W	W
Navajo -----	1	W	W	1	W	W
Pima -----	4	903	3,608	3	1,007	3,939
Pinal -----	9	538	1,773	9	581	1,884
Yavapai ¹ -----	10	641	1,199	9	1,350	3,951
Yuma -----	W	W	W	1	W	W
Undistributed -----	5	393	1,571	8	537	1,784
Total ² -----	55	3,404	11,030	51	4,147	13,921

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

¹ To avoid disclosing company proprietary data, certain county totals were incomplete for 1975; the portion not included has been included with "Undistributed."

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

Table 17.—Arizona: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Flux stone -----	962	3,175	1,075	3,482
Lime manufacture -----	465	1,602	898	3,472
Terrazzo and exposed aggregate -----	108	627	133	540
Dense-graded roadbase stone -----	116	166	W	W
Concrete aggregate -----	82	133	92	318
Roadstone -----	54	179	65	150
Refractory stone -----	W	W	5	W
Mineral food -----	3	39	1	22
Other uses ² -----	1,608	4,961	1,871	5,842
Total ³ -----	3,399	10,882	4,142	13,826

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

¹ Includes limestone, sandstone, granite, miscellaneous stone, traprock, and marble.

² Includes stone used for cement manufacture, bituminous aggregate, roofing granules, sulfur dioxide removal, macadam aggregate, acid neutralization, filter stone, railroad ballast, agricultural limestone, surface treatment aggregate, unspecified uses (1976), and uses indicated by symbol W.

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

Table 18.—Arizona: Bituminous coal production in 1976, by type of mine and county

County	Number of mines		Production (thousand short tons)		Total value
	Underground	Surface	Underground	Surface	
Navajo -----	--	2	--	10,420	W

W Withheld to avoid disclosing company proprietary data.

Table 19.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos: Jaquays Mining Corp.	1219 South 19th Ave. Phoenix, Ariz. 85009	Underground mine, crushing, screening, air-separation plant.	Gila.
Cement:			
Arizona Portland Cement Co., ¹ a division of Califor- nia Portland Cement Co.	General Delivery Rillito, Ariz. 85246	Quarry and plant ----	Pima.
Phoenix Cement Co., a divi- sion of Amcord, Inc.	3550 North Central Ave. Rm. 1501 Phoenix, Ariz. 85012	----do -----	Yavapai.
Clays:			
Filtrol Corp -----	Box 155 Sanders, Ariz. 86512	----do -----	Apache.
Copper:			
Anamax Mining Co. ^{2 3} ----	Box 127 Sahuarita, Ariz. 85629	Open pit and under- ground mines, plant.	Pima.
ASARCO Incorporated:			
Hayden unit -----	Box 98 Hayden, Ariz. 85235	Smelter -----	Do.
Mission unit ^{2 3} -----	Box 111 Sahuarita, Ariz. 85629	Open pit mine and mill	Do.
Sacaton unit ³ -----	Box V Casa Grande, Ariz. 85222	----do -----	Pinal.
San Xavier unit ³ -----	Box 111 Sahuarita, Ariz. 85629	Open pit mine -----	Pima.
Silver Bell unit ³ -----	Silver Bell, Ariz. 85270	Open pit mine, mill, leach dumps, precipi- tation plant.	Do.
Cities Service Co., Miami Copper Co. Div. ³	Box 100 Miami, Ariz. 85539	Open pit mine, mill, leach dumps, in place leaching, precipita- tion plants.	Gila.
Continental Copper Co ----	Box 662 Oracle, Ariz. 85623	Underground mine ----	Pinal.
Continental Oil Co -----	Box 649 Florence, Ariz. 85232	Mine -----	Do.
Cyprus Mines Corp.:			
Cyprus Bagdad Copper Co. ⁴	Box 245 Bagdad, Ariz. 86321	Open pit mine and mill	Yavapai.
Cyprus Bruce Copper & Zinc Co. ⁴	Box 744 Florence, Ariz. 85232	Underground mine and mill.	Do.
Cyprus Johnson Copper Co.	Drawer R Benson, Ariz. 85602	Open pit mine and mill	Cochise.
Cyprus Pima Mining Co. ⁴	Box 7187 Tucson, Ariz. 85713	----do -----	Pima.
Duval Corp.:			
Esperanza and Sierrita properties. ^{2 3}	Box 125 Sahuarita, Ariz. 85629	Open pit mines, mills, leach dumps, precipi- tation plant.	Do.
Mineral Park property. ^{2 3}	Box 1271 Kingman, Ariz. 86401	----do -----	Mohave.
Hecla Mining Co.:			
Lakeshore mine -----	Box 498 Casa Grande, Ariz. 85222	Underground mine and plant.	Pinal.
Inspiration Consolidated Copper Co. ²	Inspiration, Ariz. 85537	Open pit mine, mill, vat leaching plant, electrowinning plant, in place leaching, heap leaching, precipi- tation plant, rod plant rolling mill, custom smelter, electrolytic refinery.	Gila.
Christmas mine -----	----do -----	Open pit mine and concentrator.	Do.
Ox Hide mine -----	----do -----	Open pit mine -----	Do.
Kennecott Copper Corp.:			
Ray Mines Div. ² -----	Hayden, Ariz. 85235	Open pit mine, precipi- tation, vat leaching, electrowinning plants, smelter.	Do.
Magma Copper Co.:			
San Manuel Div. ^{1 2 3} ----	Box M San Manuel, Ariz. 85631	Underground mine, mill, smelter, re- finery.	Pinal.
Superior Div. ³ -----	Box 37 Superior, Ariz. 85273	Underground mine and mill.	Do.

See footnotes at end of table.

Table 19.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Copper—Continued:			
Phelps Dodge Corp.: Copper Queen branch ³	Drawer K Bisbee, Ariz. 85603	Open pit mine, under- ground mine, mill, leach dumps, in place leaching, precipita- tion plant.	Cochise.
Douglas Reduction Works.	Drawer E Douglas, Ariz. 85607	Smelter -----	Do.
Morenci and Metcalf branches. ³	Box 151 Morenci, Ariz. 85540 -----	Open pit mines, mill, leach dumps, precipi- tation plant.	Greenlee.
New Cornelia branch ³	Drawer 9 Ajo, Ariz. 85321	Open pit mine, mill, smelter.	Pima.
Safford branch -----	Box 151 Safford, Ariz. 85546	Underground mine ----	Graham.
Producers Mineral Corp.: Peacock mine -----	Box 226 North San Juan Rd. Safford, Ariz. 85546	Open pit mine, dump, plants.	Do.
Ranchers Exploration and Development Co.: Bluebird mine -----	Box 880 Miami, Ariz. 85539	Open pit mine, leach dump, solvent ex- traction plant, elec- trowinning plant.	Gila.
Feldspar: Arizona Feldspar Corp ----	Box 229 Kingman, Ariz. 86401	Underground mine, mill.	Mohave.
Fluorite: Tonto Mining and Milling Co.	Box 275 Tonto Basin, Ariz. 85553	Mine, mill, plant ----	Gila.
Gold:			
Magma Copper Co.: San Manuel Div -----	Box M San Manuel, Ariz. 85631	See Copper -----	Do.
Superior Div -----	Box 37 Superior, Ariz. 85273	-----do -----	Pinal.
Phelps Dodge Corp.: Copper Queen branch -	Drawer K Bisbee, Ariz. 85603	-----do -----	Cochise.
Morenci and Metcalf branches.	Box 151 Morenci, Ariz. 85540 -----	-----do -----	Greenlee.
New Cornelia branch --	Drawer 9 Ajo, Ariz. 85321	-----do -----	Pima.
Gypsum:			
National Gypsum Co -----	Star Route, Box 89 Winkelman, Ariz. 85292	Open pit mine and plant.	Pinal.
Pinal-Mammoth Gypsum --	2020 South 9th St. Coolidge, Ariz. 85228	Mine -----	Do.
Superior Companies ⁵ -----	2402 South 19th Ave. Phoenix, Ariz. 85009	Quarries and plant ---	Pinal and Yavapai.
Lime:			
Amstar Corp -----	11800 East Riggs Rd. Chandler, Ariz. 85224	Kiln -----	Maricopa.
Can-Am Corp., Paul Lime Div.	Drawer T Douglas, Ariz. 85607	5 rotary-kiln plants --	Cochise.
Kennecott Copper Corp., Ray Mines Div.	Box 960 Hayden, Ariz. 85235 -----	Kiln -----	Gila.
Phelps Dodge Corp., Morenci branch.	Morenci, Ariz. 85540 ----	Rotary kiln, fluidized- bed-kiln plant.	Greenlee.
The Flintkote Co., U.S. Lime Div.	Box 197 Peach Springs, Ariz. 86434	Nelson quarries and plant.	Yavapai.
Mica:			
Buckeye Mica Co -----	Box 416 Buckeye, Ariz. 85326	Mine and mill -----	Maricopa.
Perlite:			
Filters International, Inc --	Box Z Superior, Ariz. 85273	Open pit mine and plant.	Pinal.
Guzman Construction Co --	Box 7 Superior, Ariz. 85273	-----do -----	Do.
Harborlite Corp -----	Box 960 Superior, Ariz. 85273	-----do -----	Do.
Pumice and volcanic cinder:			
Flagstaff Cinder Sales, Inc -	Box 2796 4400 Nyla Flagstaff, Ariz. 86001	Quarry -----	Coconino.
Superlite Builders Supply, Inc.	5201 North 7th St. Phoenix, Ariz. 85014	Open pit mine -----	Do.

See footnotes at end of table.

Table 19.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Quartz:			
Hemphill Brothers, Inc ----	Box 384 Kingman, Ariz. 86401	Open pit mine -----	Mohave.
Salt:			
Southwest Salt Co -----	Box 1237 Litchfield Park, Ariz. 85340	Brine from wells -----	Maricopa.
Sand and gravel:			
Arizona Silica Sand Co ---	Box 108 Houck, Ariz. 86506	Open pit mine and plant.	Apache.
Silica flux:			
Copper Hill Mine -----	Box 752 Globe, Ariz. 85501	Mine -----	Gila.
Denning Mining Co -----	Why, Ariz. 85321 -----	Open pit mine -----	Pima.
Gilbert Construction Co ---	204 East Vista Warren, Ariz. 85603	Quarry -----	Cochise.
	Box 5288 Bisbee, Ariz. 85603		
Little Hill Mines, Inc ----	Box 332 Oracle, Ariz. 85623	Open pit mine -----	Pinal.
McFarland-Hullinger -----	Box 811 Tucson, Ariz. 85702	Plant and quarry ----	Gila.
Gordon Wainwright— Contractor.	Box G Hayden, Ariz. 85235	Open pit mine -----	Do.
O. Brice Willis -----	Box 1325 Clifton, Ariz. 85533	----do -----	Greenlee.
Stone:			
Dunbar Stone Co -----	Box 246 716 Lewis Ashfork, Ariz. 86320	Quarries -----	Coconino and Yavapai.
Valley Stone Supplies ----	Box 372 Paulen, Ariz. 86334	Quarry -----	Yavapai.
Western States Stone Co --	Box 316 Ashfork, Ariz. 86220	Quarries and plant ---	Coconino, Yavapai, Mohave, Yuma.

¹ Also lime.² Also molybdenum.³ Also silver.⁴ Also molybdenum and zinc.⁵ Also clays, diatomite, and limestone.

The Mineral Industry of Arkansas

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission, under a memorandum of understanding for collecting information on all minerals except fuels.

By Raymond B. Stroud ¹

Arkansas mineral production, comprised of fuels, nonmetallic minerals and rocks, and metallic ores, was valued at \$535.4 million in 1976, a new record high. The value was \$99 million above that of 1975. Mineral fuels contributed \$255.9 million, the major share of the State's total mineral value, and accounted for most of the value gain. The State ranked 25th in the United States in mineral output value and continued to be the largest producer of bauxite, bromine, and vanadium in the Nation. Of the 19 mineral commodities produced in the State, all but 2 registered value increases. Production of carbon black, gallium, and elemental sulfur continued, but the value of the three commodities was not included in the overall total value of mineral output. Petroleum continued to be the most prominent mineral, accounting for \$174.6 million. Bromine persisted as the most important nonmetallic mineral, and vanadium supplanted bauxite as the most significant metallic ore in terms of value.

Led by petroleum, which not only increased in value but also in quantity, mineral fuels, comprised of natural gas, natural gas liquids, and coal, registered significant increases in value. Among these, only natural gas declined in volume of production; output at 109.5 billion cubic feet was the lowest since 1966. Production of natural gas liquids gained slightly over output in 1975. Production of bituminous coal increased to 534 million tons, the largest output since 1957. Output of crude oil was nearly 2 million barrels greater

than that reported in 1975. Production of oil was recorded from more than 7,500 wells in 1976, about 200 more than produced in 1975. Investigations of lignite continued in 1976 as State agencies further defined the geological extent and character of deposits. Private industry continued widespread drilling activities and consolidated holdings blocking out minable units.

Production of nonmetallic minerals contributed heavily to the economy of Arkansas; these commodities found widespread use in the chemical, manufacturing, and building industries. Arkansas bromine output was again the second most important mineral produced. The bromine industry produced about 70% of the Nation's supply and accounted for more than half of the world's supply. Production of clays, lime, stone, sand and gravel, abrasive stone, cement, gypsum, tripoli, and barite increased as did attendant values except that of barite. However, outputs of soapstone and phosphate rock were lower. A substantial quantity of quartz crystal suitable as material for growth of cultured quartz was produced.

Bauxite and vanadium ores shared significance in the State as important sources of aluminum and vanadium, respectively, in the United States. Bauxite output increased over that of 1975 but was still slightly below the 1974 production level. Gallium production continued at one operation in association with the conversion

¹ State Liaison Officer, Bureau of Mines, Little Rock, Ark.

of bauxite to alumina. Vanadium ore was mined and processed in Garland County and a new source of supply in Hot Spring County was explored and tested in 1976.

Sporadic exploration for zinc ores continued in north Arkansas, but no announcement was made of commercial deposits.

Table 1.—Mineral production in Arkansas¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives, whetstones ----- short tons..	W	W	497	\$264
Bauxite ----- thousand long tons..	1,543	\$22,956	1,667	24,481
Clays ----- thousand short tons..	995	2,232	1,047	3,396
Coal (bituminous) ----- do..	488	16,000	534	19,310
Gem stones -----	NA	70	NA	85
Iron ore (usable), gross weight thousand long tons..	(²)	14	--	--
Lime ----- thousand short tons..	170	3,848	182	4,900
Natural gas ----- million cubic feet..	116,237	40,334	109,533	58,052
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels..	196	1,360	203	1,422
LP gases ----- do..	407	2,377	408	2,440
Petroleum (crude) ----- do..	16,133	143,336	18,097	174,636
Sand and gravel ----- thousand short tons..	12,415	25,794	³ 14,736	³ 25,848
Stone ----- do..	17,419	38,796	⁴ 17,701	⁴ 39,713
Value of items that cannot be disclosed:				
Abrasives (oilstones, 1976), barite, bromine, cement, gypsum, phosphate rock, sand and gravel (industrial, 1976), soapstone, stone (dimension, 1976), tripoli, vanadium, and values indicated by symbol W -----	XX	139,324	XX	180,901
Total -----	XX	436,441	XX	535,448
Total 1967 constant dollars -----	XX	172,700	XX	^p 192,494

^p Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data; value included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Less than ½ unit.

³ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

⁴ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Arkansas, by county¹

(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Ashley	\$81	\$38	Sand and gravel.
Baxter	W	W	Stone, sand and gravel.
Benton	W	W	Do.
Boone	404	W	Do.
Bradley	11	W	Petroleum, sand and gravel.
Calhoun	1,733	W	Sand and gravel, petroleum, natural gas.
Carroll	W	W	Stone, sand and gravel.
Chicot	W	W	Sand and gravel.
Clark	W	W	Stone, sand and gravel, clays.
Clay	111	165	Sand and gravel.
Cleburne	W	W	Stone.
Cleveland	1	W	Sand and gravel.
Columbia	W	97,905	Bromine, petroleum, natural gas, natural gas liquids, sand and gravel.
Conway	W	W	Stone, sand and gravel, natural gas.
Craighead	W	1,324	Sand and gravel, clays.
Crawford	W	W	Natural gas, stone, sand and gravel.
Crittenden	W	W	Clays, sand and gravel.
Cross	W	277	Sand and gravel, stone.
Dallas	W	W	Sand and gravel.
Drew	236	310	Do.
Faulkner	1,284	W	Stone, sand and gravel.
Franklin	W	W	Natural gas, coal, stone, sand and gravel.
Fulton	W	W	Sand and gravel, stone.
Garland	20,359	W	Vanadium, abrasives, sand and gravel, tripoli.
Grant	195	632	Sand and gravel.
Greene	125	323	Do.
Hempstead	W	W	Sand and gravel, clays.
Hot Spring	3,762	1,917	Stone, sand and gravel, clays, barite, abrasives.
Howard	13,073	16,277	Cement, stone, gypsum, clays, sand and gravel.
Independence	W	W	Stone, lime, sand and gravel.
Izard	W	7,065	Sand and gravel, stone.
Jackson	W	284	Sand and gravel.
Jefferson	W	95	Do.
Johnson	W	12,669	Natural gas, coal, sand and gravel, clays, stone.
Lafayette	W	W	Petroleum, natural gas, sand and gravel, natural gas liquids.
Lawrence	W	1,931	Stone, sand and gravel.
Lincoln	316	172	Sand and gravel.
Little River	21,368	31,286	Cement, stone, sand and gravel, clays.
Logan	W	W	Natural gas, stone, sand and gravel, coal.
Lonoke	W	W	Stone, clays.
Madison	W	W	Sand and gravel, stone.
Marion	W	765	Do.
Miller	W	18,008	Petroleum, sand and gravel, natural gas.
Mississippi	3	1	Sand and gravel.
Monroe	W	W	Do.
Montgomery	W	W	Barite, stone.
Nevada	W	W	Petroleum, sand and gravel.
Newton	W	6	Sand and gravel.
Ouachita	W	W	Petroleum, sand and gravel, natural gas, clays.
Perry	W	W	Stone.
Phillips	211	182	Sand and gravel.
Pike	W	W	Sand and gravel, gypsum, abrasives.
Poinsett	W	745	Sand and gravel.
Polk	320	324	Do.
Pope	1,007	W	Natural gas, sand and gravel, coal, stone.
Prairie	W	--	
Pulaski	W	W	Stone, clays, bauxite, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
St. Francis	260	899	Sand and gravel.
Saline	25,298	26,563	Bauxite, lime, sand and gravel, stone, clays, talc.
Searcy	W	W	Sand and gravel, stone.
Sebastian	10,435	21,266	Coal, natural gas, stone, sand and gravel, clays.
Sevier	W	397	Sand and gravel.
Sharp	307	318	Stone, sand and gravel.
Stone	W	W	Do.
Union	W	W	Bromine, petroleum, sand and gravel, natural gas.
Van Buren	W	W	Sand and gravel, phosphate rock.
Washington	W	W	Stone, sand and gravel, natural gas.
White	W	W	Stone, sand and gravel.
Woodruff	W	W	Sand and gravel.
Yell	W	66	Do.
Undistributed ²	\$35,545	293,239	
Total ³	436,441	535,448	

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

¹ Arkansas, Desha, Lee, Prairie, and Scott Counties were not listed because no production was reported.

² Includes value of petroleum and natural gas production 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

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	338.5	869.0	+3.6
Unemployment -----do-----	69.4	62.0	-10.7
Employment (nonagricultural):			
Mining -----do-----	4.4	4.7	+6.8
Manufacturing -----do-----	179.2	194.9	+8.8
Contract construction -----do-----	33.5	33.8	+9
Transportation and public utilities -----do-----	36.8	37.9	+3.0
Wholesale and retail trade -----do-----	133.1	141.3	+6.2
Finance, insurance, real estate -----do-----	27.0	28.0	+3.7
Services -----do-----	88.9	94.2	+6.0
Government -----do-----	120.9	123.2	+1.9
Total nonagricultural employment -----do-----	623.8	658.0	+5.5
Personal income:			
Total -----millions--	\$9,507	\$10,408	+9.5
Per capita -----do-----	\$4,506	\$4,934	+9.5
Construction activity:			
Number of private and public residential units authorized--	6,867	8,818	+28.4
Value of nonresidential construction -----millions--	\$79.2	\$110.4	+39.4
Value of State road contract awards -----do-----	\$139.0	\$170.0	+22.3
Shipments of portland and masonry cement to and within the State -----thousand short tons--	866	954	+10.2
Mineral production value:			
Total crude mineral value -----millions--	\$436.4	\$535.4	+22.7
Value per capita, resident population -----do-----	\$207	\$254	+22.7
Value per square mile -----do-----	\$8,219	\$10,083	+22.7

^P Preliminary.

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

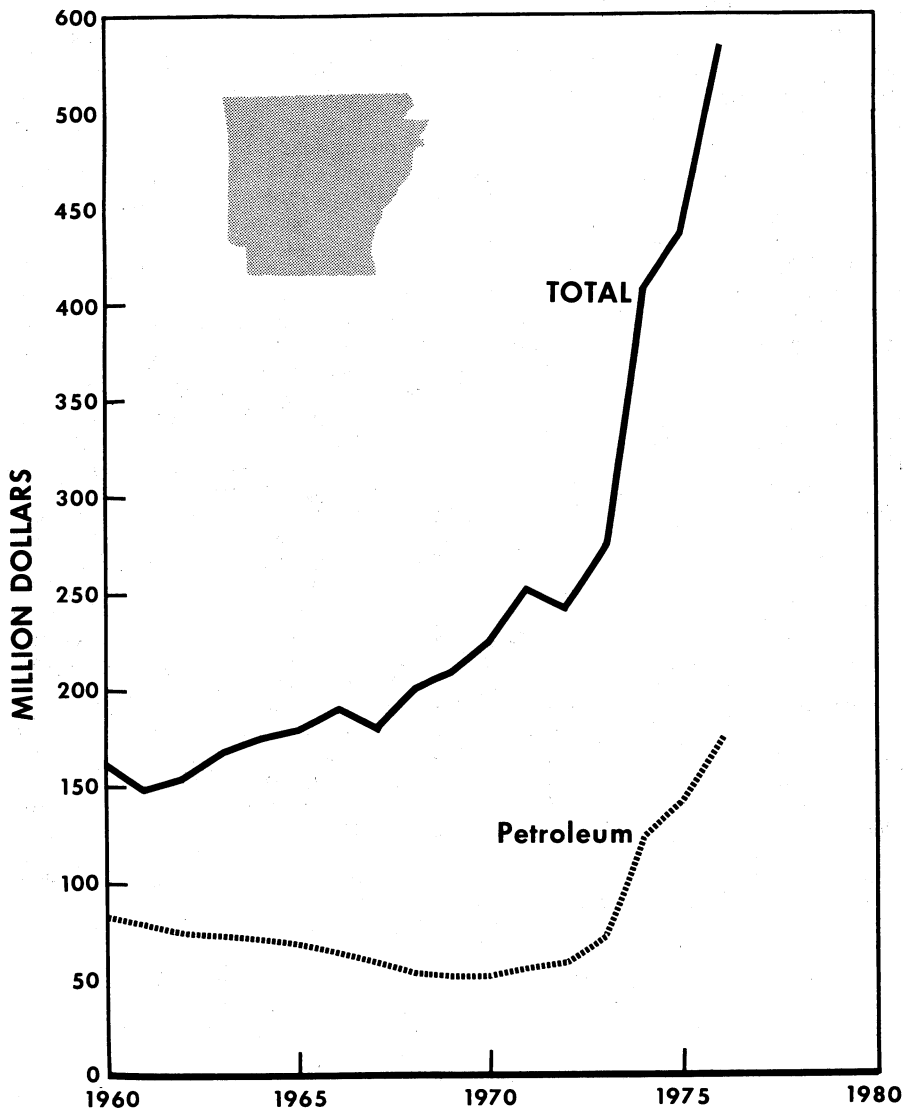


Figure 1.—Value of petroleum and total value of mineral production in Arkansas.

Trends and Developments.—Arkansas Power and Light Co., the State's largest supplier of electric power, was granted a \$20.9 million retail rate increase by the State Public Service Commission (PSC) in April 1976. This increase, added to an increase of \$20.2 million in 1975, was termed insufficient to permit adequate financing of continued construction of two coal-fired steam-electric generators at White Bluff. At yearend, the utility had not resumed construction activities, but a request for an additional \$56.4 million rate increase was pending in an application submitted to the PSC. The company did continue construction of unit 2 of Arkansas Nuclear One near Russellville in 1976. This unit will have a net capacity of 912 megawatts and has an estimated cost of more than \$446 million. Initial operation was scheduled to begin in 1978. Unit 1 of the nuclear installation had produced more than 9 billion kilowatt-hours of electric power since its startup in December 1974 to the end of 1976.

Southwestern Electric Power Co. and Arkansas Electric Co-op. continued construction of their coal-fired generating plant near Gentry. This 528-megawatt plant will be fired by coal from the AMAX Belle Ayr mine in Wyoming. Coal consumption was estimated to be 1.75 million tons annually. Startup of operations was scheduled for the spring of 1978.

According to U.S. Army Corps of Engineers preliminary reports, tonnage moved on the Arkansas River Navigation System established a new record in 1976, as 6.3 million tons of commodities were shipped by barge. The increase was 1.1 million tons higher than that of 1975 and about 200,000 tons greater than that reported in 1974, the previous record year. Minerals and mineral products comprised 83.1% of the total tonnage shipped. Sand and gravel comprised about one-third of the total shipments. Bauxite imports resumed in 1976 to about 282,000 tons.

The Arkansas State Chamber of Commerce reported in its 26th Annual Inventory of Industrial Growth that \$534.4 million in capital expenditures was programed for business and industrial expansions and new plants, which was about \$30.3 million above that reported in 1975. In addition, expenditures for utilities, transportation, communications, and elec-

tric cooperatives reached an alltime record of \$356.6 million in 1976. Arkansas Power & Light Co. invested \$174.7 million in construction of new facilities. Spending for new manufacturing and processing plants and expansions to existing plants that utilize minerals or mineral products were reportedly in excess of \$102 million. Three bromine producers programed about \$36 million for plant expansions.

Arkansas Eastman Co., a subsidiary of Eastman Chemicals Div. of Eastman Kodak Co., had nearly completed construction of its \$30 million organic chemicals manufacturing plant near Batesville. Chemicals made at the plant will be used in photographic processing and film production.

A Belgium firm, Bekaert Steel Wire Corp., began operations at its \$24 million plant near Van Buren in September. Bekaert is the first foreign-owned corporation to construct a plant in Arkansas. Production was expected to reach capacity by 1979 when an estimated 40,000 tons of wire products will be produced annually.

Arkansas residential construction contracts increased to \$491.2 million in 1976, a 31.5% gain over contracts recorded in 1975. Nonresidential contracts totaled \$284.4 million in 1976, a \$2.7 million increase over those of 1975. Personal income in Arkansas in 1976 was \$10.8 billion compared with \$9.2 billion in 1975, according to data furnished by the University of Arkansas, Bureau of Business and Economic Research.

The agriculture industry in Arkansas used 714,405 tons of fertilizer in fiscal year 1976 according to the Arkansas Crop and Livestock Reporting Service. Farmers used 399,197 tons of mixed fertilizers, 36% more than in fiscal year 1975, and 315,208 tons of direct application materials, 11% more than in fiscal year 1975.

Legislation and Government Programs.—Contractors for the U.S. Army Corps of Engineers completed construction of an access road to the proposed \$57 million Felsenthal Lock and Dam site in southwest Ashley County. Contracts for dam construction were scheduled for letting in late summer 1977. The project is part of a plan to develop a 9.5-foot channel to provide improved navigation facilities on the Ouachita-Plack River System. It was estimated that about \$99 million

total would be spent on the Arkansas part of the project.

The State of Arkansas received about \$104,890 in 1976 from the Bureau of Land Management, U.S. Department of the Interior, as the State share of funds from Federal mineral leasing revenues. Most of the revenue was from leasing of land for natural gas exploration and production from National Forest areas in north Arkansas.

The U.S. Geological Survey in concert with the Arkansas Geological Commission completed work on the new geologic map of Arkansas following about 6 years of efforts. The new map replaces the last geologic map issued in 1929. A number of changes were made in stratigraphic and structural interpretations. The map is available from the Arkansas Geological Commission in Little Rock at a cost of \$3.50.

The Arkansas Department of Pollution Control and Ecology administers the State's mined-land reclamation act. The regulations became effective July 1, 1971. Since that time, the Department has issued 137 permits to 48 mining operations. Permit fees for 4,236 acres have been collected and deposited in the State Treasury. Bond and escrow agreements total \$3,067,500. At the end of fiscal year 1977, a total of 456 acres of mined land had been reclaimed satisfactorily, and reclamation was in progress on an additional 1,787 acres. In 1976, permits were issued covering 1,858 acres for mining of various commodities. During 1976, 301 acres of

coal-mined land was reclaimed and released from bond.

The Pollution Control and Ecology Department issued 18 permits to the mineral industry to install air pollution control equipment having an estimated cost of \$8.6 million. The Department also issued eight permits to the mineral industry to install water pollution control equipment at an estimated cost of \$360,000.

The Arkansas Governor appointed a Coal Mine Examining Board to revise outdated State mining regulations and to give examinations to prospective coal miners. In both instances, the efforts were to bring the State into conformation with Federal Health and Safety mining regulations. The U.S. Department of Interior, through its Mining Enforcement and Safety Administration (MESA) gave the State \$135,000 to develop a training program. These efforts were underway at yearend.

Employment.—The Employment Security Division, Arkansas Labor Department, reported that the mineral industry payroll totaled \$57.3 million for 4,671 total workers in 1976. Total weekly wages paid to people employed in mineral production increased nearly 14% and an additional 239 employees were reported over comparable data for 1975. In 1976, workers in metal mining received \$275.33 per week; coal miners received an average \$398.25 per week; \$234.81 was paid to workers producing crude oil and natural gas; and persons employed in production of nonmetallic minerals and in quarry operations received an average of \$192.31 per week.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Combined value of petroleum, natural gas, coal, and natural gas liquids, listed in order of significance, accounted for \$255.9 million in 1976. The total value was nearly \$50 million greater than that reported in 1975. Significantly, the total value of mineral fuels in 1976 was greater than the total combined value of all minerals—fuels, nonmetallics, and metals—recorded for Arkansas in 1972 (\$241.2 million). With exception of bituminous coal output, production volumes of other fuel minerals decreased or remained station-

ary during the 5-year period, thus indicating the large value gains for fuel minerals that had great impact on the Arkansas economy. Petroleum registered a substantial gain in production over that of 1975 and the total value of \$174.6 million was the highest value assigned to a single mineral commodity produced in the State. Natural gas production was valued at \$58,052,000, the highest of record, but output dropped to 109.5 billion cubic feet. Output of natural gas liquids was essentially equal to that of 1975 and value increased slightly. Production of bituminous

coal exceeded one-half million tons, the largest output in 20 years.

Carbon Black.—Production of carbon black was reported at the El Dorado plant of Columbian Carbon Division of Cities Service Co. for the 25th consecutive year. Output of the commodity decreased, but value was up more than 20% over that reported in 1975, reflecting higher prices of feedstocks. Most carbon black is used in the rubber industry in fabricating automobile tires.

Coal (Bituminous).—Production of coal increased to 534 million tons in 1976, a gain of 9.4% over that of 1975. Value of production increased correspondingly to \$19.3 million. Unit value in 1976 was an average \$36.16. Eight mining companies reported outputs of 1,000 tons or more during the year. Production increased at one underground operation in Sebastian County, and strip mines were operated in Sebastian, Johnson, Franklin, and Logan Counties. Sugarloaf Mining Co., a subsidiary of National Steel Corp., continued operation of its coal-washing plant in Sebastian County. A new company, Lake Providence Producers, began construction

of a coal cleaning plant utilizing an air separation process at yearend. The plant was scheduled for operation in 1977. Plant capacity would range from about 80 to 120 tons per hour.

Interest in Arkansas bituminous coal continued at a high level. Some 30 companies, including those in production, have been issued mining permits by the State Pollution Control and Ecology Department.

Lignite, a brownish-black coal, which occurs over widespread areas in eastern and southern Arkansas, continued to be investigated by the Arkansas Geological Commission and a number of private companies. In several counties, tracts aggregating several thousand acres have been leased and partially explored. In some instances, consolidation of minable blocks of land was underway, and private companies were conducting research on the utility of the lignite. In late 1976, the Federal Bureau of Mines sampled bituminous coal deposits in the coalfields near Fort Smith and lignite deposits at scattered points in south Arkansas for laboratory research studies.

Table 4.—Arkansas: Bituminous coal production, by type of mine and county, in 1976

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Underground	Surface	Underground	Surface	
Franklin -----	--	4	--	114	W
Johnson -----	--	4	--	159	W
Logan -----	--	1	--	10	W
Pope -----	--	1	--	13	W
Sebastian -----	1	1	30	208	W
Total -----	1	11	30	504	\$19,310

W Withheld to avoid disclosing individual company confidential data; included in "Total."

Natural Gas.—Marketed production of natural gas decreased for the sixth consecutive year. In 1976, 109.5 billion cubic feet of natural gas was marketed compared with 116.2 billion cubic feet in 1975 and 181.4 billion cubic feet in 1970, the peak year of production. Natural gas was produced in conjunction with crude oil in eight contiguous south Arkansas counties.

The wet gas, in part, was treated in seven gas-cleaning plants to recover liquid hydrocarbons, LP gases, and byproduct

sulfur in some instances. Dry natural gas was produced in 10 northwest Arkansas counties in the Arkansas Valley area of the Arkoma Basin. Franklin County led all counties in production, and the greatest volume of natural gas was produced in the Arkoma Basin area of the State. Proved reserves of natural gas in Arkansas, according to the American Gas Association (AGA), decreased from 1,993,273 million cubic feet in 1975 to 1,728,271 million cubic feet in 1976, a 13.3% decline.

According to the 1976 annual report of the Arkansas Oil and Gas Commission, six gas storage reservoirs in northwest Arkansas contained 10.5 billion cubic feet of natural gas at the end of 1976. At year-

end, 60 gasfields existed in northwest Arkansas, the site of most of the natural gas reserves in the State; 5 of the gasfields were not connected to pipeline outlets.

Table 5.—Arkansas: Gross withdrawals and disposition of natural gas
(Million cubic feet)

	Gross withdrawals ¹			Disposition			
	From gas wells	From oil wells	Total	Marketed production ²		Repressuring	Vented and wasted ³
				Quantity	Value (thousands)		
1972 -----	125,319	43,852	169,171	166,522	\$28,808	--	2,649
1973 -----	120,068	39,408	159,476	157,529	28,985	--	1,947
1974 -----	92,265	33,426	125,691	123,975	32,234	--	1,716
1975 -----	91,270	30,248	121,518	116,237	40,334	3,963	1,818
1976 -----	91,166	29,981	121,147	109,533	58,052	10,387	1,227

¹ Marketed production plus quantities used in repressuring, vented, and wasted.

² Comprises gas sold or consumed by producers, including losses in transmission, quantities added to storage, and increases in gas in pipelines.

³ Includes direct waste on producing properties and residue blown to air.

Natural Gas Liquids.—Production of natural gas liquids, including natural gasoline and cycle products and liquefied petroleum gases recovered through the treatment of wet natural gases at seven south Arkansas gas processing plants, totaled 611,000 barrels in 1976 and was valued at \$3.9 million. Production and value of the commodities were essentially unchanged in comparison with 1975 data. The seven plants (five plants operated in 1975) that processed natural gas in 1976 were as follows: Arkansas Chemical Corp.'s Hamilton plant, Columbia County; Phillips Petroleum Co.'s McKamie plant in Lafayette County; O. B. Mobley, Jr.'s plant in the Lewisville field, Lafayette County; American Petrofina's plant, Day Creek field, Miller County; the H. A. Chapman and Beacon Gasoline Co. plants, Walker Creek field, Columbia County; and the Branch Investments Corp. plant, West Bradley field in Lafayette County. The last three plants named were new installations in 1976, although the H. A. Chapman plant replaced an older operation belonging to H. A. Chapman that was operated in 1975.

Proved reserves of natural gas liquids including condensate, natural gasoline, and LP gases, according to AGA, were 7.3 million barrels at yearend, compared with 3.8 million barrels in 1975, an increase of 89%.

Petroleum.—Petroleum production in 1976 increased by nearly 2 million barrels over that reported in 1975. Unit value increased to \$9.65 per barrel from \$8.89 per barrel in 1975. Value of the crude oil output accounted for 32.6% of the total value of the State's mineral production. Eight counties—Miller, Lafayette, Nevada, Columbia, Union, Ouachita, Calhoun, and Bradley—recorded oil outputs. The Arkansas Oil and Gas Commission reported crude oil production from 7,529 wells in 177 fields in South Arkansas; some wells were also producers of natural gas. These data reflect gains of 221 producing wells and 9 oilfields over comparable data for 1975.

Secondary recovery projects in 1976 accounted for 7,748,243 barrels of oil, an increase of more than 1.7 million barrels of oil over that from secondary recovery programs in 1975. Oil production from these 65 recovery projects accounted for about 42.8% of the State's total output. Disposal of saltwater, produced in conjunction with crude oil, was carried out through the use of 422 saltwater disposal wells. About 33.8 million barrels of saltwater were injected for secondary recovery operations, and 161.5 million barrels were piped to underground injection wells.

Leading fields in oil production in south Arkansas were the Smackover, Walker

Creek, and Chalybeat Springs operations with more than 1 million barrels of oil production in each in 1976.

Proved reserves of crude oil, according to the American Petroleum Institute

(API), were 93.4 million barrels at the end of 1976, a decrease of about 2.2 million barrels when compared with the 1975 data.

Table 6.—Arkansas: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Dec. 31, 1975	Changes in proved reserves due to revisions, extensions, and discoveries in 1976	Proved reserves Dec. 31, 1976 (production deducted)	Change from 1975 (percent)
Crude oil -----thousand barrels--	95,662	15,207	93,489	-2.3
Natural gas liquids -----do----	3,852	4,458	7,279	+89.0
Natural gas -----million cubic feet--	1,993,273	265,002	1,728,271	-13.3

Sources: American Petroleum Institute and American Gas Association.

Table 7.—Arkansas: Crude petroleum production, indicated demand, and stocks in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within Arkansas
January -----	1,399	2,155	684
February -----	1,339	1,265	758
March -----	1,443	1,320	881
April -----	1,444	2,024	301
May -----	1,493	976	818
June -----	1,513	1,588	743
July -----	1,595	1,697	641
August -----	1,582	1,623	600
September -----	1,579	1,504	675
October -----	1,588	1,586	677
November -----	1,565	1,568	674
December -----	1,557	1,451	780
Total:			
1976 -----	18,097	18,757	XX
1975 -----	16,183	15,546	XX

XX Not applicable.

Petroleum and Natural Gas Exploration and Development.—According to the API, 430 wells were drilled in 1976, an increase of 109 wells over 1975 figures. Total footage drilled was tabulated at 2,055,611 feet, which was more than 400,000 feet greater than in 1975. Of the wells drilled, 217 were oil productive, 45 produced natural gas, and 168 were dry holes. Overall success ratio was nearly 61%. Ten wells (9 oil and 1 gas) of a total 76 wells, classified as exploratory, produced hydrocarbons. Oil or gas, sometimes simultaneously, was found in 252 wells out of a total 354 wells drilled in proved oil and gasfields.

The Arkansas Oil and Gas Commission

reported discovery of eight new oilfields and four new oil pools in south Arkansas. Two new fields were found in each of Columbia and Lafayette Counties, three new fields were found in Union County, and one new field was found in Nevada County. New oil pools were found in Miller (two), Ouachita (one), and Union (one) Counties.

The Commission reported discovery of three new gasfields in north Arkansas, two in Conway County and one in Madison County. Exploratory or field wells were drilled in 11 counties and 29 gasfields. There were 1,223 producing gas wells in north Arkansas at yearend.

Table 8.—Arkansas: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Ashley	--	--	--	--	--	1	1	9,972
Bradley	6	--	--	--	--	2	8	22,924
Calhoun	--	--	--	--	--	2	2	5,196
Cleburne	--	--	--	--	--	1	1	5,271
Columbia	46	6	16	2	--	13	83	686,975
Crawford	--	--	1	--	1	--	2	8,594
Franklin	--	11	6	--	--	--	17	86,006
Hempstead	--	--	--	--	--	1	1	6,300
Johnson	--	11	5	--	--	1	17	60,814
Lafayette	18	1	17	2	--	5	43	236,205
Logan	--	--	1	--	--	--	1	4,744
Madison	--	2	1	--	--	3	6	4,319
Miller	11	1	8	1	--	10	31	176,869
Nevada	3	--	11	1	--	6	21	67,258
Ouachita	43	--	7	1	--	6	57	161,600
Pope	--	2	2	--	--	1	5	34,379
Sebastian	--	9	1	--	--	--	10	72,024
Union	81	1	26	2	--	11	121	480,170
White	--	--	--	--	--	1	1	6,779
Woodruff	--	--	--	--	--	1	1	6,760
Yell	--	--	--	--	--	1	1	13,462
Total	208	44	102	9	1	66	480	2,955,611

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Petroleum Refineries.—Four petroleum refineries were operated in Arkansas in 1976—Lion Oil Co., a division of TOSCO Corp., at El Dorado, Union County; Mac-Millan Ring-Free Oil Co., Inc., at Norphlet, Union County; Cross Oil and Refining Co. at Smackover, Union County; and Berry Petroleum Co., a division of Crystal Oil Co., at Stephens, Ouachita County. Combined capacity of the refineries totaled 61,000 barrels per day, of which 1,800 barrels per day capacity was shutdown at the Cross refinery at the end of 1976. Although some refineries produced few petroleum products, collectively the companies produced gasoline, kerosine, diesel fuel, motor oil, asphalts, lubricating oils, naphtha, jet fuels, fuel oils, wax distillates, and protective coatings. The four refineries processed a total of 19,826,376 barrels of crude oil in 1976, an increase of 614,835 barrels of crude oil from the 1975 figure. An average of 54,319 barrels of crude oil was processed on a daily basis in 1976. Lion Oil Co. continued to make significant improvements to its El Dorado refinery to add to its product line. The company also enhanced its crude oil sources of supply when a 467-mile crude oil pipeline extending from the Texas gulf coast to Oklahoma was completed. A branch line from the mainline serves the Lion Oil refinery.

NONMETALS

Output of 13 nonmetallic minerals in Arkansas greatly enhanced the economy of the State. Nearly 1,600 workers employed in the nonmetallic segment of the State's mineral industry received about \$16 million in weekly earnings in 1976. Many of the commodities are utilized in the State for the manufacture of products and in building and construction industries. With two exceptions—phosphate rock and soapstone—gains in quantitative production were reported by the mineral industry.

Abrasive Stone.—Arkansas novaculite, produced almost exclusively for whetstone and oilstone manufacture, increased in value in 1976; output also increased over that reported in 1975. Production was reported in three counties—Garland, Hot Spring, and Pike—and eight companies reported mining and processing the unique, near pure silica rock. Some novaculite was used as aggregate for construction and a lesser amount was used in refractory manufacture.

Barite.—Output of barite was slightly above that reported in 1975. The Baroid Division, NL Industries, Inc., mined barite in two Arkansas counties. Crude ore was treated in a flotation plant operated by the company in Hot Spring County. The company completed mining of barite ore

in the Pigeon Roost district in Montgomery County and began open-pit mining at a deposit in the Fancy Hill district in the same county.

The Milwhite Co. continued its operation at Bryant, Saline County, where crude barite ore was ground and processed. All of the barite produced in Arkansas was used in the manufacture of drilling muds.

Bromine.—Arkansas bromine producers expanded production to a new record high level in 1976. A new \$15 million bromine extraction plant was brought onstream in February by Great Lakes Chemical Corp., joining one other company plant in Union County. Elemental bromine was also produced by Velsicol (formerly Michigan Chemical Corp.) and Arkansas Chemicals Inc. at plants in Union County. The Dow Chemical Co. and Ethyl Corp. (formerly Bromet) continued to produce elemental bromine in Columbia County. Ethyl Corp. began a \$15 million expansion of its facilities, and Velsicol began a \$9 million expansion at its extraction plant near El Dorado. Bromine was the second most valuable mineral produced in the State. More than one-half of bromine output was used to manufacture ethylene dibromide. More than half of the world's supply of bromine was produced in Arkansas.

Cement.—Shipments and sales of both portland and masonry cement increased significantly in 1976. Combined shipments of the cements was up nearly 20% and value was about 37% higher than in 1975. Principal markets for cement continued to be ready-mix concrete companies, building contractors, and concrete product manufacturers. Both Ideal Cement Co. and Arkansas Cement Co. began using coal as fuel in limited quantities; however, natural gas was used as the main fuel to fire cement kilns. Limestone (chalk), clay, sand, and gypsum and iron oxides were used in the manufacture of cement.

Clays.—Eleven companies produced a variety of clays in Arkansas in 1976. Total output, including kaolin, exceeded 1 million tons and was about 5% greater than tonnage reported in 1975. Value of the production, however, gained substantially and was about \$1.2 million higher than that recorded in 1975. Clay production was reported from 13 counties from a total of 19 clay pits operated in the State. Clays were used in cement manufacture in two counties, lightweight aggregate was produced in two counties, and kaolin was produced in two counties. Five companies manufactured face brick from clays mined at 12 separate pits. Some companies operated mines in more than one county; however, most companies had only one operating clay pit. Leading producing counties were Hot Spring, Crittenden, Lonoke, Johnson, and Sebastian.

Gem Stones.—Crater of Diamonds State Park in Pike County again highlighted gem stone activities in Arkansas. Park officials reported that tourists found 398 diamonds with a total carat weight of 98.76. A few of the diamonds were in the 1- to 2-carat class and were suitable as precious gems.

Wavellite and jasper production was also notable, as were mineral specimens of quartz crystal. Production of quartz crystal of industrial-grade quartz suited for use as feedstock to synthesize quartz for electronic applications exceeded 500,000 pounds and had an estimated value of \$325,000.

Gypsum.—Production of gypsum rebounded in 1976 as output climbed 16% over that of 1975. Value of the commodity showed a comparable increase over the 1975 value. Because gypsum was used primarily in products utilized by the construction industry, the increase was attributable to increased building and construction. Arkansas Gypsum Co. in Pike County continued to supply ground gypsum as an

additive in cement manufacture, and Weyerhaeuser Co. mined and processed gypsum primarily for use in wallboard manufacture in Howard County. Temple Gypsum, Inc., manufactured wallboard at its plant in West Memphis using crude gypsum mined in Oklahoma.

Lime.—Aluminum Company of America (Alcoa) and Reynolds Metals Co. were major producers of lime that was used at respective company plants in Saline County where bauxite is converted into alumina. The companies utilized high-calcium limestone that was mined in Izard County. Rangaire Corp. produced lime in Independence County for use in the paper and pulp industries for soil stabilization, water purification, and other uses. Output of lime in Arkansas increased about 7% and value gained nearly 27% over that of 1975. The production gain was sufficient to set a new record in the State. The lime was used primarily in Arkansas and substantial shipments were made to Louisiana, Tennessee, and other States.

Phosphate Rock.—Jon-T Phosphates, Inc., continued mining operations at a phosphate rock deposit near the boundary common to Searcy and Van Buren Counties in north-central Arkansas. A major problem in exploiting the deposit is increasing thickness of overburden, which will require underground development. Production of elemental-grade phosphate

rock was down 50% in 1976. Much of the crushed rock was shipped out-of-State to a Tennessee Valley Authority (TVA) plant in Alabama where it was converted to elemental phosphorus. Part of the phosphate rock output was crushed to minus 100 mesh and sold for direct application as a soil amendment.

Sand and Gravel.—Production and value of sand and gravel increased over that reported in 1975. Output of sand and gravel was reported in 66 counties from 252 operations. The five leading counties in order of significance of production were: Calhoun, Miller, Crawford, Ouachita, and Pulaski. Craighead and Calhoun Counties led in number of sand and gravel mines with 15 and 14, respectively. Sand and gravel was the seventh most important mineral product of the State in terms of mineral value. Nine Arkansas counties reported outputs in excess of 500,000 tons each, and production was widespread representing all types of geologic environments. Most of the output was used as concrete aggregate for all types of construction, and the Arkansas State Highway and Transportation Department was the major single market. Important quantities of sand and gravel were used in concrete products and a multitude of industrial applications. Silica sand was produced in Izard County for the 56th consecutive year.

Table 9.—Arkansas: Sand and gravel sold or used, by major use category¹
(Thousand short tons and thousand dollars)

Use	1976	
	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	5,014	10,701
Concrete products (cement blocks, bricks, pipe, etc.)	1,576	3,449
Asphaltic concrete aggregates and other bituminous mixtures	2,106	4,846
Roadbases and coverings	4,808	4,952
Fill	1,054	1,323
Other uses	177	576
Total²	14,736	25,848

¹ Excludes industrial sand and gravel.

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

Soapstone.—The Milwhite Co., Inc., mined and processed talc-bearing rock for the 24th consecutive year in Saline County. Quantity of output decreased slightly in 1976, but the value increased substantially compared with 1975 data. Plant products were used primarily as dusting agents for

rubber goods and asphalt shingles.

Stone.—Production of stone, including chalk (a variety of limestone), limestone, nepheline syenite (classified as granite), slate, novaculite, sandstone, and dimension stone (cut sandstone) increased slightly in 1976. Value also increased slightly and

was sufficient to rank stone production as the fifth most important mineral commodity produced in the State. Leading stone producers were McGeorge Contracting Co., Arkhola Sand & Gravel Co. (Ashland Oil Inc.), and Minnesota Mining & Manufacturing Co. A total of 83 quarries were operated by the stone industry in 35 counties for production of diverse stone types. Among all States in the Nation, Arkansas ranked second in output of crushed sandstone, third in crushed slate, and fifth in crushed granite (nepheline syenite). The five leading counties were Pulaski (syenite), Little River (chalk), Independence (limestone), Izard (limestone), and Lawrence (limestone), listed in order of production significance. Stone output in Pulaski County was by far the most important.

Most of the State's sandstone output was from five counties—Crawford, Sebastian, Faulkner, Clark, and White Counties—ranked in order of production. Four companies quarried dimension sandstone for cut building stone.

All of the State's syenite (granite) was quarried from nine operations in Pulaski County. Limestone was produced from 34 quarries in 14 counties; chalk was mined in Little River and Howard Counties for cement manufacture. Leading limestone producing counties were Little River, Independence, Izard, Lawrence, and Washington.

Slate was produced in Montgomery and Saline Counties. Novaculite was quarried in Hot Spring County.

Principal uses of the major stone types—syenite, limestone, and sandstone—were for roadbase stone, cement manufacture, bituminous paving mixes, concrete aggregate, roofing granules, riprap and jetty stone, railroad ballast, lime manufacture, and agricultural limestone.

Sulfur (Recovered Elemental).—Three companies reported byproduct sulfur recovery from processing of wet, sulfur-bearing natural gases in south Arkansas. These were Arkla Chemical Corp. at its Hamilton plant in Columbia County, Phillips Petroleum Co. at its McKamie plant in Lafayette County, and Lion Oil Co. at its El Dorado refinery in Union County. However, Ethyl Corp. led the State in sulfur recovery as a byproduct at its bromine extraction plant in Columbia

County. Total production of elemental sulfur reported by the four companies was 14,003 long tons that was valued at \$818,000 in 1976.

Tripoli.—Malvern Minerals Co. in Garland County was the only producer of tripoli in the State in 1976. Output of tripoli increased 77% and attendant value was up 36% as compared with 1975 information. Tripoli was used as a filler in various compounds but was mainly consumed as polish for metal parts.

Vermiculite.—Crude vermiculite, mined out-of-State, was processed by W. R. Grace & Co. at its plant in Pulaski County and by Strong-Lite Products Co. at its plant in Jefferson County. The plant product, exfoliated vermiculite, was used as a concrete aggregate, plaster aggregate, block and loose fill insulation, for fireproofing, in horticulture, and in other uses.

METALS

Bauxite and vanadiferous clays were the main metal-bearing ores produced in Arkansas and were the principal domestic sources of aluminum and vanadium, respectively, in the United States. Gallium was recovered in connection with the conversion of bauxite to alumina at one plant in Arkansas. Although sporadic, efforts continued in north Arkansas to discover new sources of zinc and lead principally in areas that were once productive. No production of iron ore was reported in 1976.

Aluminum.—Production of aluminum in Arkansas, which had been reduced to a low level in 1975 as a result of depressed market conditions, began to recover by late spring in 1976. Operations at the Reynolds Metals Co. Jones Mill aluminum reduction plant were resumed after the plant had been idle throughout 1975. The Reynolds aluminum plant near Arkadelphia in Clark County resumed capacity production; only one potline was closed down in 1975. The Reynolds Company also reopened its aluminum wire and cable plant in Hot Spring County.

Reynolds Metals Co. and Aluminum Company of America (Alcoa) continued production of alumina at their respective plants in Saline County. Both companies had reduced outputs in 1975, but in 1976 production facilities reached near rated capacities.

The Alcoa operation, which produces alumina mainly for chemical uses, was not affected to the same extent as the Reynolds plant, at which most of the alumina output goes into aluminum production. The Alcoa operation at Benton also produced gallium in conjunction with treatment of bauxite ores.

Bauxite.—Production of bauxite in Arkansas increased over that of 1975 as three producers—Alcoa, American Cyanamid Co., and Reynolds Mining Co.—reported gains in mine output. Reynolds Mining Co. (a subsidiary of Reynolds Metals Co.) closed its Mars Hill mine, the last remain-

ing underground bauxite mine in the State, in early March 1976. The State's bauxite output was sufficient to account for about 85% of the total bauxite produced in the United States. Bauxite processing plants were operated by Alcoa, Reynolds Metals Co., American Cyanamid Co., Porocel Corp., and Stauffer Chemical Co. Plant products included alumina, alumina chemicals, and activated and calcined bauxite. Reynolds Metals Co. resumed imports of bauxite into Arkansas in March, and by yearend, the company reported shipments in excess of 280,000 tons.

Table 10.—Arkansas: Mine production of bauxite and shipments from mines and processing plants to consumers in the United States
(Thousand long 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
1972	1,973	1,634	21,010	2,127	1,844	25,085
1973	2,040	1,686	23,384	2,076	1,780	26,703
1974	2,098	1,731	23,597	2,130	1,810	26,737
1975	1,862	1,543	22,956	1,883	1,599	25,486
1976	2,013	1,667	24,481	2,035	1,723	27,580

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

Vanadium.—Mining of vanadiferous clays and production of vanadium oxide, that later was converted to ferrovandium compounds outside Arkansas, was recorded for the ninth consecutive year by Union Carbide Corp. in Garland County. The

company reported that initial research work to recover vanadium from ores mined at Magnet Cove, Hot Spring County, was successful. Ore bodies known in that area are scheduled for mining as reserves at the Wilson Springs area are depleted.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Malvern Minerals Co -----	Box 1246 Hot Springs, Ark. 71901	Mine -----	Garland.
Norton-Pike Co -----	Littleton, N.H. 03561 -----	---do -----	Do.
Barite:			
NL Industries, Inc -----	Box 1675 Houston, Tex. 77001	Mine and plant ---	Hot Spring and Montgomery.
Bauxite:			
Aluminum Company of America. ¹	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	---do -----	Saline.
American Cyanamid Co ---	Berdan Ave. Wayne, N.J. 07470	---do -----	Do.
Reynolds Metals Co. ² -----	Box 398 Bauxite, Ark. 72011	---do -----	Do.
Bromine:			
Arkansas Chemicals, Inc --	Route 6, Box 98 El Dorado, Ark. 71730	Brine wells and plant.	Union.
The Dow Chemical Co ----	Midland, Mich. 48640 -----	---do -----	Columbia.
Ethyl Corp. ³ -----	451 Florida St. Baton Rouge, La. 70801	---do -----	Do.
Great Lakes Chemical Corp.	Box 2200 West Lafayette, Ind. 47901	---do -----	Union.
Velsicol Chemical Corp ---	351 East Ohio St. Chicago, Ill. 60611	---do -----	Do.
Carbon black:			
Cities Service Co -----	3200 West Market St. Akron, Ohio 44313	Furnace -----	Do.
Cement:			
Arkansas Cement Corp. ⁴ --	Foreman, Ark. 71836 -----	Pit and plant -----	Little River.
Ideal Basic Industries, Inc. ⁴	420 Ideal Cement Bldg. Denver, Colo. 80202	---do -----	Howard.
Clays:			
Acme Brick Co -----	Box 425 Fort Worth, Tex. 76101	---do -----	Hot Spring and Sebastian.
Arkansas Lightweight Aggregate Corp.	El Dorado, Ark. 71730 -----	---do -----	Crittenden and Lonoke.
W. S. Dickey Clay Manufacturing Co.	Texarkana, Ark. 75501 -----	---do -----	Miller.
Coal:			
Crown Construction Co., Inc.	Fort Smith, Ark. 72901 ---	Strip mine -----	Johnson.
Garland Coal & Mining Co	---do -----	---do -----	Franklin.
Peabody Coal Co -----	St. Louis, Mo. 63102 -----	---do -----	Johnson.
Sugarloaf Mining Co -----	Fort Smith, Ark. 72901 ---	Strip and under- ground.	Sebastian.
Gypsum:			
Weyerhaeuser Co -----	Route 4, Box 78 Nashville, Ark. 71852	Mine and plant --	Howard.
Iron ore:			
Leber Mining Co -----	36 South Market St. Elizabethtown, Pa. 17022	---do -----	Nevada.
Lime:			
Rangaire Corp. ⁵ -----	Box 1311 Batesville, Ark. 72501	Plant -----	Independence.
Natural gas liquids:			
Arkla Chemical Corp. ³ ----	Magnolia, Ark. 71753 -----	---do -----	Columbia.
Phillips Petroleum Co. ³ ---	Stamps, Ark. 71860 -----	---do -----	Lafayette.
Petroleum refineries:			
Berry Petroleum Co -----	Magnolia, Ark. 71753 -----	Refinery -----	Ouachita.
Cross Oil & Refining Co. of Arkansas.	Smackover, Ark. 71762 -----	---do -----	Union.
Lion Oil Co. ³ -----	El Dorado, Ark. 71730 -----	---do -----	Do.
MacMillan Ring-Free Oil Co., Inc.	Norphlet, Ark. 71759 -----	---do -----	Do.
Roofing granules:			
Bird and Son, Inc -----	East Walpole, Mass. 02032 --	Plant -----	Montgomery.
Minnesota Mining & Manufacturing Co.	Little Rock, Ark. 72203 ---	---do -----	Pulaski.
Sand and gravel:			
Arkholia Sand & Gravel Co.	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	Pit -----	Crawford.
Gifford-Hill & Co., Inc ---	Box 47127 Dallas, Tex. 75247	Pit -----	Lafayette and Miller.
Jeffrey Sand Co., Inc -----	Fort Smith, Ark. 72901	Dredge -----	Pulaski.

See footnotes at end of table.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Arkholo Sand & Gravel Co.	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	Pit -----	Crawford.
Freshour Construction Co.	Box 77 Sweet Home, Ark. 72164	Quarries -----	Sharp, Van Buren, White.
Ben M. Hogan Co., Inc. ---	Box 2860 Little Rock, Ark. 72203	----do -----	Lawrence and Pope.
McClinton Brothers Co. ---	Box 1367 Fayetteville, Ark. 72701	----do -----	Benton, Madison, Washington.
McGeorge Contracting Co. --	Box 248 Pine Bluff, Ark. 71601	Quarry -----	Pulaski.
Midwest Lime Co. -----	Box 608 Batesville, Ark. 72501	----do -----	Independence.
Minnesota Mining & Manufacturing Co.	Little Rock, Ark. 72203	----do -----	Do.
Talc and soapstone:			
The Milwhite Co., Inc. ⁵ ---	Box 15038 Houston, Tex. 77020	Mine and plant ---	Saline.
Vanadium:			
Union Carbide Corp. -----	Route 2, Box 563 Hot Springs, Ark. 71901	Mine and mill ----	Garland.
Vermiculite (exfoliated):			
Strong-Lite Products -----	Pine Bluff, Ark. 71601	Plant -----	Jefferson.

¹ Also lime and cement.² Also lime.³ Also recovered sulfur.⁴ Also clay and stone.⁵ Also stone.

The Mineral Industry of California

This chapter has been prepared under a cooperative agreement for the collection of mineral data between the Bureau of Mines, U.S. Department of the Interior, and the California Department of Conservation, Division of Mines and Geology.

By William H. Kerns¹

The total value of all minerals produced in California in 1976 increased to \$3.5 billion, a 10% advance compared with that of 1975. This overall advance of \$330 million resulted primarily from increased prices received for the mineral commodities produced and marketed during 1976.

Crude petroleum continued to be by far the most important mineral product in California, in terms of value, accounting for \$2 billion or 58% of the State's total value of mineral production. This was an increase of \$62 million compared with that of 1975. Natural gas production accounted for \$333 million or 10% of the total. This was an increase of \$110 million compared with that of 1975. Cement (portland) output contributed \$294 million or 8% of the State's total, an increase of \$61 million. Sand and gravel output valued at \$202 million was an increase of \$34 million and contributed 6% of the State's total. Boron minerals accounted for \$185 million, 5% of the State's total, and natural gas liquids output was valued at \$57 million or 2% of the State's total. Together the six mineral com-

modities—petroleum, natural gas, cement (portland), sand and gravel, boron minerals, and natural gas liquids—accounted for 88% of the State's total value of output in 1976.

Other important nonmetals produced, in descending order of output value, included stone, diatomite, magnesium compounds, lime, sodium sulfate, salt, sodium carbonate, potassium salts, asbestos, clays, gypsum, pumice, talc, and feldspar. Together these 14 commodities accounted for an additional 8% of the State's total.

Four commodities—iron ore, tungsten, rare earths, and gold—were the leading metals produced, supplying 3% of the State's total output value in 1976.

The remainder of the total value of mineral production came from the output of copper, lead, mercury, molybdenum, silver, zinc, calcium chloride, gem stones, lithium minerals, peat, perlite, and phosphate rock. In all, 36 mineral commodities were produced in California in 1976.

¹ State Liaison Officer (retired), Bureau of Mines, Sacramento, Calif.

Table 1.—Mineral production in California¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Asbestos -----short tons--	W	W	78,390	\$15,706
Barite -----thousand short tons--	1	W	—	—
Boron minerals -----do--	1,172	\$158,772	1,246	184,852
Cement:				
Masonry -----do--	1	34	1	48
Portland -----do--	7,326	232,550	7,896	293,645
Clays -----do--	² 2,387	² 7,373	2,296	13,570
Copper (recoverable content of ores, etc.)				
-----short tons--	344	441	375	522
-----thousand short tons--	354	31,186	386	37,372
Gem stones -----do--	NA	220	NA	231
Gold (recoverable content of ores, etc.)				
-----troy ounces--	9,606	1,551	10,392	1,302
Gypsum -----thousand short tons--	1,446	6,332	1,647	7,897
Iron ore (usable)				
-----thousand long tons, gross weight--	W	W	3,042	W
Lead (recoverable content of ores, etc.)				
-----short tons--	66	23	54	25
Lime -----thousand short tons--	595	18,626	633	23,324
Mercury -----76-pound flasks--	W	W	296	36
Natural gas -----million cubic feet--	318,308	222,816	354,334	333,074
Natural gas liquids:				
Natural gasoline and cycle products				
-----thousand 42-gallon barrels--	4,847	29,543	4,626	31,655
LP gases -----do--	4,481	20,568	4,151	25,487
Petroleum (crude) -----do--	322,199	1,943,048	326,021	2,005,577
Pumice -----thousand short tons--	348	2,762	705	3,245
Sand and gravel -----thousand short tons--	88,445	168,248	96,592	202,272
Silver (recoverable content of ores, etc.)				
-----thousand troy ounces--	80	353	57	249
Stone -----thousand short tons--	33,152	72,740	32,377	75,352
Talc -----short tons--	152,978	1,598	56,871	1,513
Zinc (recoverable content of ores, etc.) -----do--	206	161	170	126
Value of items that cannot be disclosed:				
Bromine (1975), calcium chloride, carbon dioxide, clays (ball clay and kaolin, 1975), feldspar, lithium compounds, magnesium compounds, molybdenum, peat, perlite, phosphate rock (1976), potassium salts, rare-earth metal concentrates, salt, sodium carbonate, sodium sulfate, tungsten concentrate, and values indicated by symbol W--	XX	233,937	XX	226,293
Total -----	XX	3,152,937	XX	3,433,373
Total 1967 constant dollars -----	XX	1,247,617	XX	^P 1,252,273

^P Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes ball clay and kaolin; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in California, by county¹

(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Alameda -----	W	W	Sand and gravel, salt, stone, petroleum, clays.
Alpine -----	\$217	\$107	Gold, silver, sand and gravel, zinc, lead, copper.
Amador -----	W	W	Clays, sand and gravel, stone.
Butte -----	5,336	2,638	Sand and gravel, stone.
Calaveras -----	20,031	32,635	Cement, asbestos, stone, sand and gravel, clays.
Colusa -----	W	W	Stone, sand and gravel.
Contra Costa -----	12,869	8,511	Stone, lime, petroleum, sand and gravel, clays.
Del Norte -----	1,274	1,277	Stone, sand and gravel, gold.
El Dorado -----	W	W	Stone, lime, sand and gravel, talc.
Fresno -----	80,789	76,894	Petroleum, sand and gravel, natural gas liquids, asbestos, stone, clays, gold, tungsten.
Glenn -----	W	W	Sand and gravel, lime, stone.
Humboldt -----	3,527	2,484	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in California, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Imperial -----	W	W	Gypsum, lime, sand and gravel, salt.
Inyo -----	\$26,397	\$33,152	Tungsten, boron minerals, talc, molybdenum, copper, stone, perlite, sand and gravel, silver, pumice, zinc, clays, lead, gold.
Kern -----	920,874	1,086,799	Petroleum, boron minerals, cement, natural gas liquids, stone, sand and gravel, gypsum, clays, carbon dioxide, salt, tungsten, pumice.
Kings -----	8,803	W	Natural gas liquids, petroleum.
Lake -----	W	W	Sand and gravel, pumice.
Lessen -----	67	167	Pumice, sand and gravel, stone.
Los Angeles -----	646,238	593,245	Petroleum, sand and gravel, natural gas liquids, stone, lime, clays, tungsten, silver.
Madera -----	3,011	1,137	Sand and gravel, pumice, stone, tungsten.
Marin -----	W	W	Stone, clays.
Mariposa -----	54	W	Sand and gravel, stone.
Mendocino -----	562	998	Do
Merced -----	1,810	1,932	Sand and gravel, stone, gold.
Modoc -----	W	W	Peat, sand and gravel, stone, pumice.
Mono -----	1,757	1,604	Pumice, clays, stone, sand and gravel, gold, silver, zinc, lead, copper.
Monterey -----	118,271	114,629	Petroleum, magnesium compounds, lime, sand and gravel, stone, feldspar.
Napa -----	2,665	2,790	Salt, stone, sand and gravel, mercury, pumice.
Nevada -----	W	W	Sand and gravel, stone, clays.
Orange -----	216,681	207,188	Petroleum, sand and gravel, natural gas liquids, clays, lime, stone.
Placer -----	W	W	Sand and gravel, clays, stone.
Plumas -----	638	1,486	Stone, sand and gravel, gold, pumice, copper, silver, lead, zinc.
Riverside -----	W	122,692	Iron ore, cement, sand and gravel, stone, clays, petroleum.
Sacramento -----	23,203	W	Sand and gravel, gold, stone, clays.
San Benito -----	9,217	10,943	Asbestos, stone, sand and gravel, petroleum, clays.
San Bernardino -----	225,865	274,214	Cement, boron minerals, sodium sulfate, sodium carbonate, potash, stone, rare-earth minerals, sand and gravel, lime, clays, salt, petroleum, magnesium chloride, lithium, iron ore, talc, feldspar, pumice, gypsum, tungsten.
San Diego -----	22,384	29,086	Sand and gravel, stone, salt, magnesium compounds, clays, tungsten.
San Francisco -----	W	--	
San Joaquin -----	14,870	7,696	Sand and gravel, lime, peat, gold, stone.
San Luis Obispo -----	11,568	W	Petroleum, sand and gravel, stone, clays.
San Mateo -----	9,141	10,791	Magnesium compounds, stone, salt, petroleum, sand and gravel.
Santa Barbara -----	156,212	153,254	Petroleum, diatomite, natural gas liquids, sand and gravel, lime, phosphate rock, stone.
Santa Clara -----	W	W	Cement, stone, sand and gravel, mercury.
Santa Cruz -----	W	W	Cement, sand and gravel, stone, clays.
Shasta -----	9,511	12,758	Cement, sand and gravel, stone, clays, pumice, copper, gold, silver, lead.
Sierra -----	212	608	Gold, stone, silver.
Siskiyou -----	1,137	1,886	Sand and gravel, stone, pumice.
Solano -----	34,643	1,655	Stone.
Sonoma -----	5,915	W	Sand and gravel, stone, petroleum.
Stanislaus -----	W	W	Sand and gravel, gold, clays.
Sutter -----	W	W	Sand and gravel, clays.
Tehama -----	W	W	Sand and gravel, stone, pumice.
Trinity -----	W	W	Stone, sand and gravel, gold.
Tulare -----	3,596	2,805	Sand and gravel, petroleum, clays, stone, tungsten.
Tuolumne -----	W	W	Lime, stone, gold.
Ventura -----	164,987	156,793	Petroleum, natural gas liquids, sand and gravel, clays, stone, pumice.
Yolo -----	19,214	W	Sand and gravel, lime, stone.
Yuba -----	W	W	Sand and gravel, gold, stone, clays.
Undistributed ² -----	369,393	523,516	
Total ³ -----	3,152,937	3,483,373	

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

¹ Value of petroleum is based on an average price per barrel for the State.

² Includes natural gas 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

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands...	9,380	9,708	+3.5
Unemployment ----- do.....	925	889	-3.9
Employment (nongricultural):			
Mining ----- do.....	33.9	34.9	+2.9
Manufacturing ----- do.....	1,586.8	1,646.7	+3.8
Contract construction ----- do.....	303.3	318.3	+4.9
Transportation and public utilities ----- do.....	459.1	463.6	+1.0
Wholesale and retail trade ----- do.....	1,788.3	1,871.4	+4.6
Finance, insurance, real estate ----- do.....	446.8	468.9	+4.9
Services ----- do.....	1,543.2	1,613.1	+4.5
Government ----- do.....	1,667.9	1,708.4	+2.1
Total nongricultural employment ----- do.....	7,829.3	8,120.3	+3.7
Personal income:			
Total ----- millions...	\$138,719	\$153,892	+10.9
Per capita ----- do.....	\$6,544	\$7,151	+9.3
Construction activity:			
Number of private and public residential units authorized ----- do.....	131,248	220,134	+67.7
Value of nonresidential construction ----- millions...	\$2,470	\$2,736	+10.8
Value of State road contract awards ----- do.....	\$186.9	\$430.0	+130.1
Shipments of portland and masonry cement to and within the State ----- thousand short tons...	6,848	7,303	+6.6
Mineral production value:			
Total crude mineral value ----- millions...	\$3,152.9	\$3,483.4	+10.5
Value per capita, resident population ----- do.....	\$149	\$162	+8.7
Value per square mile ----- do.....	\$19,868	\$21,950	+10.5

^P Preliminary.

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

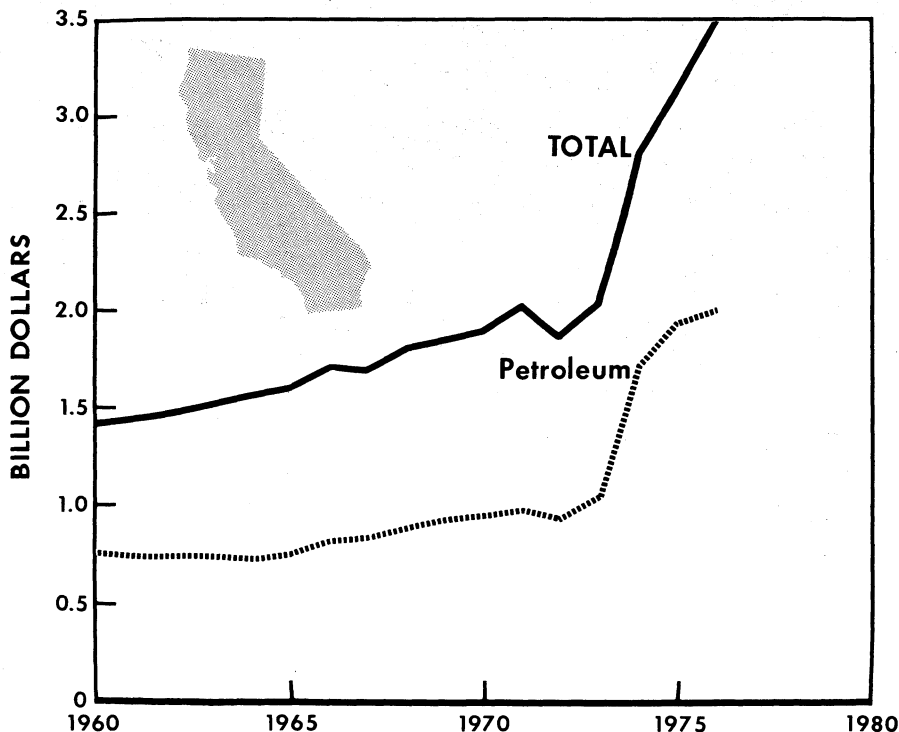


Figure 1.—Value of petroleum and total value of mineral production in California.

Legislation and Government Programs.

—When the State Legislature adjourned its 1975-76 2-year session on August 31, 1976, 7,492 bills had been introduced. Of this number, 3,067 had been passed by the legislature and signed into law by the Governor. The advantage of this biennial session, the second 2-year session, is that it allows the legislators more time to consider complex and highly technical legislation. The following summarizes those bills that became law during 1976 and that were made a part of the California Statutes of 1976 that may have an impact on the mineral industries in California:

Assembly Bill (AB) 400 (Chapter 1440), Senate Bill (SB) 1277 (Chapter 1330), and AB 2948 (Chapter 1331).—Together these three bills constituted the California Coastal Act of 1976, which established in the California Resources Agency the California Coastal Commission and for a designated period, six regional coastal commissions. The bills also established coastal management goals and policies with respect to public access, recreation, marine environment, land resources, and industrial development. Funding was also provided for carrying out these provisions.

AB 3590 (Chapter 958).—Provided for a State Geothermal Task Force to study all aspects of developing the geothermal resources of the State. It would require the Secretary of the California Resources Agency and the Director of the Office of Planning and Research to transmit the final report of the task force to the legislature and the Governor by July 1, 1977. It would terminate the existence of the task force 6 months after transmittal of such report.

AB 3833 (Chapter 664).—The State Energy Resources Conservation and Development Commission, under existing law, was required to develop and coordinate a program of research and development in alternative sources of energy. This bill authorized participation, as defined, in large-scale demonstrations of alternative energy systems sited in California in cooperation with Federal agencies, regional compacts, other State governments, and other participants.

AB 3884 (Chapter 557).—Required geologic and soil engineering studies only for school sites located within special study zones designated as geologically hazardous in the seismic safety element of the general plan.

AB 4018 (Chapter 557).—Specified damages of unlawful conversion or appropriation of State-owned or reserved mineral deposits under the jurisdiction of the State Lands Commission.

AB 4026 (Chapter 834).—Deleted an existing allowance of 5 cents per barrel on royalties paid to the State Lands Commission in leasing State lands for oil treatment and dehydration and would prohibit making any allowance for the cost of oil treatment, dehydration, or transportation of royalty oil on leases let subsequent to January 1, 1977.

AB 4029 (Chapter 1090).—Authorized the State oil and gas supervisor to order specified work to be carried out in connection with any oil or gas well which he determines to be a hazardous well.

AB 4447 (Chapter 942).—Specified royalty for mineral deposits leased from the State Lands Commission.

SB 78 (Chapter 1300).—Abolished the Division of Forestry in the Department of Conservation and established the Department of Forestry, leaving the Division of Mines and Geology, the Division of Oil and Gas, and the Division of Resource Conservation in the Department of Conservation, which is in the State Resources Agency.

SB 218 (Chapter 168).—Allowed every taxpayer to deduct from State income taxes an amount equal to the lesser of 10% of the cost or \$1,000 of the acquisition cost of solar energy devices installed on premises owned or controlled by the taxpayer.

SB 1581 (Chapter 1073).—Clarified existing law regarding the release of oil, gas, and geothermal well records to the public.

SB 1845 (Chapter 1243).—Abolished the Geologic Hazards Technical Advisory Committee and the Strong Motion Instrumentation Program Advisory Committee and transferred their functions to the Seismic Safety Commission.

SB 1827 (Chapter 794).—Increased the indemnity bond to be filed with the State oil and gas supervisor by persons engaged in the drilling, redrilling, or deepening of oil, gas, or geothermal wells to \$25,000 for a single well and \$250,000 for operations involving one or more wells at a time.

SB 1950 (Chapter 1267).—Specified that the State would not be held liable for damages resulting from an earthquake for actions taken or not taken by the State.

Senate Joint Resolution (SJR) 32 (Resolution Chapter 54).—Requested the President of the United States and the Congress to take prescribed action with respect to strip mining and open pit mining, including nullifying a specific proposal to authorize such mining in the Los Padres National Forest situated in Ventura County.

SJR 53 (Resolution Chapter 123).—Memorialized the U.S. Geological Survey, the Federal Bureau of Mines, and the California Division of Mines and Geology to intensify their efforts to catalogue those mineral resources of critical importance to the future economy of California that are within and adjacent to urban areas. It also requested local governments to protect such critical mineral resources, access thereto, and the mining thereof within their jurisdictions by special zoning, and to require mine operators to conduct operations as compatibly as practicable with their surroundings and to rehabilitate depleted mined lands for subsequent beneficial use. It also requests the California Division of Mines and Geology to make demand projections for the critical mineral commodities used in California, so that local governments are aware of their future mineral resources requirements and may plan better for the use of the deposits available to them.

In accordance with California SB 756 (Chapter 1131, Statutes of 1975, Surface Mining and Reclamation Act of 1975), on January 1, 1976, the 11-member State Mining and Geology Board was abolished and a new 9-member board was established. The new board held its first meeting in June 1976. During the remainder of the year the board completed two major requirements under the Act: (1) Adopted State policy for the reclamation of mined lands entitled "Policy and Guidelines for the Reclamation of Mined Lands in California," and (2) adopted the "Recommendations for Program Emphasis in the California Division of Mines and Geology." Principal recommendations for implementation by the Division of Mines and Geology were to (1) classify mineral content of urbanizing lands, (2) surface mine reclamation research, (3) improve mineral commodity records, (4) augment earthquake hazard reduction efforts, (5) increase basic geologic studies, and (6) accelerate coastal research and river sediment studies.

Under the California Surface Mining and Reclamation Act of 1975, the 58 counties and more than 400 cities must adopt ordinances requiring submission of reclamation plans prior to surface mining operations or disturbances from underground mining operations. The counties and cities (lead local agencies) are responsible under State standards for granting permits for such operations. The newly constituted State Mining and Geology Board sets standards and hears appeals.

Several reports on basic geology, engineering geology, and mineral resources covering specific areas in California were published by the California Division of Mines and Geology.²

The California Division of Mines and Geology active fault mapping program (Alquist-Priolo Studies Zone Act of 1972) was established in Chapter 7.5, Public Resources Code. The objective of the program is to provide for the public safety from surface rupture in hazardous fault zones by restricting construction astride active fault breaks. Under the Act, the State Geologist delineates special studies zones about one-quarter mile wide along potentially hazardous faults, starting with the States' four major faults. A report reviewing the Division's 3 years of administering the active fault mapping program was published.³

The State of California Strong Motion Instrumentation Program was established in Chapter 1152 of the Statutes of 1971, and the California Division of Mines and Geology was designated the responsible managing agency. The objective of the program is to obtain detailed records of the ground

² California Division of Mines and Geology. *Geologic Hazards in Southwestern San Bernardino County, Calif. Spec. Rept. 133, 1976, 40 pp.*

—. *Engineering Geology of the Geysers Geothermal Resource Area, Lake, Mendocino, and Sonoma Counties, Calif. Spec. Rept. 122, 1976, 35 pp.*

—. *Geology and Engineering Geologic Aspects of the South Half Tustin Quadrangle, Orange County, Calif. Spec. Rept. 126, 1976, 28 pp.*

—. *Geology and Engineering Geologic Aspects of the Laguna Beach Quadrangle, Orange County, Calif. Spec. Rept. 127, 1976, 32 pp.*

—. *Basic Geology of the Santa Margarita Area, San Luis Obispo County, Calif. Bull. 199, 1976, 45 pp.*

³ California Division of Mines and Geology. *Active Fault Mapping and Evaluation Program, Ten Year Program to Implement Alquist-Priolo Special Studies Zones Act. Spec. Pub. 47, 1976, 42 pp.*

response motion of representative soil and rock units during earthquakes, and on the response behavior of all types of structures to those earthquake-generated ground motions.⁴

Accomplishments of the California Division of Mines and Geology, 1975-76, were published as the Sixty-Ninth Report of the State Geologist.⁵

The San Francisco Bay area has produced more than \$2.5 billion in mineral resources but future production could be curtailed by urban growth, environmental constraints, and resource depletion, according to a U.S. Geological Survey report.⁶ This mineral resource map was compiled from information supplied by the California Division of Mines and Geology and was published on a special topographic base map prepared by the Association of Bay Area Governments. The map and report are products of the San Francisco Regional Environment and Resource Planning Study, a cooperative effort between the U.S. Geological Survey and the U.S. Department of Housing and Urban Development for planners and others interested in the future of the San Francisco Bay area.

U.S. Senate Bill 2371 was signed into law and, among other things, withdrew the Death Valley National Monument from location of mining claims under the mining laws. It also stopped all new mining developments in the Death Valley National Monument for 4 years while a U.S. Government study evaluates the mining properties for possible acquisition, which would almost certainly stop mining in the monument.

Title VI of the Federal Land Policy and Management Act of 1976 (Public Law 94-579), referred to as the "BLM Organic Act," among other things, established the California Desert Conservation Area, consisting of 25 million acres, 20,000 square miles, one-quarter of the land area of California. While only one-half of this area is national resource land administered by the U.S. Bureau of Land Management (BLM), the Bureau was given the lead in planning for the area. The law adopted the two-pronged approach developed earlier by

BLM with concurrent elements of long-range planning and interim management. The Secretary of the Interior was directed to prepare and implement by September 30, 1980, a comprehensive long-range plan for the management, use, development, and protection of public lands within this California Desert Conservation Area. It further directed that such plan take into account the principles of multiple use and sustained yield in providing for resource use and development, including, but not limited to, maintenance of environmental quality, rights-of-way, and mineral development.

The Act further requires that BLM involve the public heavily in the planning process. This is done in a number of ways, but a key element is the California Desert Conservation Area Advisory Committee. This committee consists of a group of distinguished citizens representing a broad spectrum of disciplines, interests, and uses. The 4-year timetable presents BLM with a planning challenge that is unique in size, scope, and importance. The first 2 years of the 4-year study will be devoted to making resource inventories, which are the most important elements of a land use plan.

A report giving the 1975-76 highlights of the California Solid Waste Management Board was published.⁷ All counties had submitted preliminary solid waste management plans to the board by August 1976, and 37 of the 58 final plans had been approved. The board's review of proposed disposal sites, transfer stations, and waste-processing or resource-recovery facilities was completed. A statewide survey was conducted to investigate potential markets for material and energy products derived from solid waste.

⁴ California Division of Mines and Geology. Second Report on the Strong-Motion Instrumentation Program. Spec. Pub. 48, Apr. 1, 1976, 39 pp.

⁵ California Division of Mines and Geology. Sixty-Ninth Report of the State Geologist, 1975-1976, 1976, 63 pp.

⁶ Bailey, E. H., and D. R. Haden. Mineral Resources of the San Francisco Bay Region, Calif.—Present Availability and Planning for the Future. U.S. Geol. Survey, Map 1-909, 1976.

⁷ California Solid Waste Management Board. California Solid Waste Management Board, 1975-1976 Highlights, 1976, 16 pp.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—Interpace Corp. continued to produce lignite from the McGuire pit near Ione, Amador County, and recover montan wax from it by solvent extraction. It was the only producer of coal in California and the only producer of montan wax in the United States. The wax is marketed for use in shoe polishes, floor waxes, carbon paper, electrical insulating compositions, and other miscellaneous uses. Since 1948, the montan wax plant at Ione has supplied all of the U.S. needs.

A report on the history of coal, including the geology, occurrences, quantity, and uses, in California was published.⁸

The known coal resources in California are estimated to be more than 100 million tons, of which about 50% is lignite coal, 40% subbituminous, and 10% bituminous.

A number of cement producers in California have acquired out-of-State coal supplies to insure long-term fuel sources. Plans were announced for the construction of coal-fired electric generating plants in the State using out-of-State coal.

Geothermal.—Twenty geothermal exploration (prospect) wells were drilled in California in 1976, an increase of 100% compared with that of 1975. Eighteen geothermal development wells were drilled in 1976, compared with 17 in 1975. Geothermal wells completed to production increased to 30 wells in 1976 from 21 wells in 1975. In 1976, 121 notices were filed to drill temperature wells, a decrease of 61, compared with 308 notices filed in 1975.⁹

In The Geysers geothermal field, 18 development wells were drilled and completed in 1976, a 1-well increase over that of 1975. Currently, all commercial geothermal steam production from The Geysers field generates a net of 502 megawatts of electricity (MWe) per day, the equivalent of 13,700 barrels of oil per day. Three additional powerplants are under construction in The Geysers field, units 12, 14, and 15 are slated to produce 106 MWe, 110 MWe, and 55 MWe of power, respectively. Unit 13, with a generating capacity of 135 MWe, is scheduled for operation as Lake County's first geothermal powerplant. When unit 13 is placed online, the combined generating capacity for The Geysers will be 908 MWe per day. The 1976 price paid for geothermal

steam produced at The Geysers was 11.35 mills per kilowatt-hour, compared with 7.39 mills in 1975. The price for 1977 will be 14.18 mills.

In the Salton Sea field, the Geothermal Loop Experimental Test Facility began operation in June 1976. A joint venture of San Diego Gas and Electric Co. and the Federal Energy Research and Development Administration (ERDA), the binary cycle system converts geothermal energy into electrical energy utilizing production and injection wells drilled by Imperial Magma Co. (Magma Power Co.). The 10-megawatt pilot facility, with a simulated generating turbine, will test the technical and economic feasibility of using the high-temperature and high-salinity brines of the Salton Sea geothermal field. In the past, corrosion and scaling problems have been the main deterrent to geothermal development in the Salton Sea field.

The University of California Lawrence Livermore Laboratory (LLL) was awarded a contract from ERDA to provide technical assistance to the project. LLL will evaluate the causes of precipitation and scaling, identify and characterize the chemistry of the brines passing through the plant, and study corrosion of critical plant components.

Imperial County was awarded a research grant by the National Science Foundation in 1975 to develop county geothermal resources. The project, scheduled for completion by June 1977, includes the development of a geothermal section in the county general plan and a utilization document for other areas which are developing geothermal resources. Project participants are researching the nature, quality, extent, and economic potential of Imperial geothermal resources as well as the social and environmental impacts of geothermal development. The research has been subcontracted to the University of California at Riverside and to the California Institute of Technology. Three steering committees composed of government officials and representatives from private industry provide guidance, advice, and technical input on research efforts.

⁸ California Division of Mines and Geology. History of Coal in California, Calif. Geol., September 1976, pp. 202-208.

⁹ California Division of Oil and Gas, 62nd Annual Report of the State Oil and Gas Supervisor. No. PRO6, 1976, pp. 131-136.

An Imperial Valley geothermal component test facility, open to private industry, universities, and government agencies to test equipment made to convert geothermal resources into useful forms of energy, was built on the Federal Bureau of Reclamation site at East Mesa. The project is a joint undertaking of ERDA and Bureau of Reclamation with technical and administrative support provided by the University of California at the Lawrence Berkeley Laboratory. The Bureau of Reclamation has worked at the East Mesa site since 1971 to study the desalinization of thermal fluids. The fluids could provide a new source of fresh water for the Lower Colorado River Basin. In 1976, TRW Systems, Inc., contracted with ERDA and Bureau of Reclamation to design limited geothermal testing facilities on the East Mesa site. The goal of the investigation is an assessment of the production potential and longevity of the East Mesa geothermal field.

To provide operational and testing services in step with the increased geothermal activity in California, the California Division of Oil and Gas (CDOG), delineated three geothermal districts in California. Administrative offices for district G-1, which includes most of northern California, and G-2, all of southern California, are located in the Sacramento and Long Beach district offices of CDOG, respectively. District G-3 administrative office, which regulates operations in Lake, Mendocino, Napa, and Sonoma Counties, is located in Sacramento, and a new field office for this district was opened in Santa Rosa in January 1976.

An industry appraisal of geothermal energy was made and published.¹⁰ The blowout of a geothermal well in The Geysers geothermal field was described.¹¹

Natural Gas.—Marketed production of natural gas, as reported by the Federal Bureau of Mines, was 354,334 million cubic feet (MMcf), an increase of 11%, compared with that of 1975. The total value of marketed production increased to \$333 million, an increase of 49%, because of an increased price from 70 cents per Mcf to 94 cents per Mcf.

Natural gas statistics and summaries of the natural gas operations in California in 1976 were published by CDOG¹² and by the Conservation Committee of California Oil Producers.¹³

According to the CDOG, the amount of natural gas produced from oil zones was 160,596,803 Mcf in 1976, a 14.7% decrease compared with that of 1975. However, gas production from the State's 77 active gasfields and 14 active gas zones increased to 174,622,457 Mcf, a 0.6% increase compared with that of 1975. Recoverable gas reserves, as of December 31, 1976, were estimated at 4.7 trillion cubic feet. During 1976, 10 new oil- and gasfields were discovered, of which 7 were gasfields and 3 were oilfields and productive areas were extended in 8 fields, 3 gas and 5 oil.

According to the Conservation Committee of California Oil Producers, natural gas production in California showed a slight increase during 1976. Combined oilfield and dry gasfield net supply increased by 1.4% to 866,000 Mcf per day average. Imports from out-of-State were down 4.5% from that of 1975, being 3,976,000 Mcf per day. Development drilling was nearly the same as that of 1975 with 62 wells completed for 1976, compared with 60 in 1975. Exploratory drilling was also active for dry gas in the Sacramento Valley, and eight new field discoveries of record were made during 1976.

Imports of natural gas from Canadian, Permian, and Delaware Basins (west Texas and southeast New Mexico) fields, Anadarko Basin fields, San Juan Basin (northwest New Mexico and southwest Colorado) fields, and Paradox Basin (southeast Utah and northeast Arizona) fields for 1976 averaged 3,976 million cubic feet per day, according to the Conservation Committee of California Oil Producers. The total volume of imported gas was equal to approximately 27% of the State's inventory of proved, recoverable gas reserves as estimated at year-end by the Committee on Natural Gas Reserves of the American Gas Association. The total gas volume received from out-of-State sources during the year was 4.5% below the 1975 total and marked the fourth consecutive year of decline from these sources. Several applications to bring out-of-State natural gas supplies into California were filed with the Federal Power Commission.

¹⁰ Olson, H. J., and W. M. Dolan. *Geothermal Energy—An Industry Appraisal*. Min. Cong. J., March 1976, pp. 18-21.

¹¹ Bacon, C. F. *Blowout of a Geothermal Well, The Geysers Geothermal Field, Sonoma County, California*. Calif. Geol. January 1976, pp. 13-18.

¹² Work cited in footnote 9.

¹³ Conservation Committee of California Oil Producers. *Annual Review of California Oil and Gas Production*. 1976, 181 pp.

Natural Gas Liquids.—Output of natural gasoline and cycle products declined 5% in quantity and increased 7% in total value compared with that of 1975. Output of liquid petroleum gases declined 7% in quantity and increased 7% in total value compared with that of 1975. According to the CDOG, 91,937 barrels of condensate was produced from California dry gasfields onshore and 30,773 barrels from State-owned offshore lands in 1976.

Peat.—Output of peat declined slightly compared with that of 1975. Moss peat was produced by Radel, Inc., near Likely, Modoc County, and reed-sedge peat was produced by Delta Humus Co. near Holt, San Joaquin County.

Petroleum.—Crude petroleum production in California increased from 322 million barrels in 1975 to 326 million barrels in 1976, an advance of 1%. The value of production increased from \$1.943 billion in 1975 to \$2.006 billion in 1976, an advance of 3%.

Crude petroleum statistics and summaries of oil operations in California in 1976 were published by the CDOG¹⁴ and by the Conservation Committee of California Oil Producers.¹⁵

According to the CDOG, California's oil was produced from 236 active fields at a rate of about 855,548 barrels per day. There were 42,534 oil wells in operation at the end of 1976, an increase of about 1,500 compared with that of 1975. Kern County produced approximately 43% of the State's total oil, surpassing oilfields in the Los Angeles Basin that accounted for 36% of the total in 1976. The largest boost in Kern County's oil production came from the Elk Hills field (Naval Petroleum Reserve No. 1). Other significant production increases resulted from steam-injection projects in Kern River, Midway-Sunset, and South Belridge oilfields. The year 1976 was the record production year for all three of these fields.

Incremental oil production, resulting from all types of enhanced recovery projects, accounted for 48% of California's total oil production. Steam stimulation was credited with 27% of the State's total and waterflood operation accounted for 20%.

Although offshore tidelands production continued to decline in 1976, it still accounted for 18% of California's crude oil production. During 1976, restrictions continued on the search for new reserves and on the further development of proved fields within State tidelands.

According to the CDOG, California's estimated recoverable oil reserves, as of December 31, 1976, totaled 4.8 billion barrels. Considering both estimated reserves and State cumulative oil production as of December 31, 1976, 78% of California's presently recoverable oil resources have been extracted.

Total footage drilled for new wells in 1976 was 6.8 million feet and rework footage was 165,615 feet, according to the CDOG. The average depth for new wells was 2,549 feet. Although footage increased about 4% in 1976, deep-well drilling declined. Only two wells were drilled deeper than 15,000 feet in 1976, compared with six in 1975.

During the year, 10 new fields were discovered (7 gasfields and 3 oilfields), 9 new pools in oilfields were discovered, and the productive areas of 8 fields (3 gas and 5 oil) were extended. The Subsidence Abatement Fund was abolished in mid-1976, but the division will continue subsidence monitoring in the Wilmington oilfield as part of normal oil and gas operations. Rapidly disappearing open space throughout the Los Angeles Basin brought urban development into increasingly closer contact with oilfield operations. As a result, many environmental as well as operational problems have arisen between oil operators and city governments. Several cities either passed new or rewrote existing ordinances to reflect a desire for more compatible interaction with oil companies and to allow a more diversified use of the land surface. Progress continued on the hazardous-sump elimination program conducted by the division and the State Department of Fish and Game. The number of oilfield sumps determined to be hazardous or immediately dangerous to wildlife has been reduced from 4,065 in 1971 to 64 by the close of 1976.

¹⁴ Work cited in footnote 9.

¹⁵ Work cited in footnote 13.

Table 4.—California: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Alameda	--	--	2	--	--	1	3	8,191
Colusa	--	1	1	--	2	3	7	38,030
Contra Costa	1	2	5	--	2	5	15	67,251
Fresno	54	--	6	2	--	10	72	236,158
Glenn	--	5	5	--	4	8	22	99,720
Humboldt	--	--	--	--	--	2	2	7,907
Kern	1,410	9	38	17	--	49	1,523	3,192,171
Kings	2	--	--	1	--	2	5	41,431
Los Angeles	60	--	4	1	--	5	70	239,750
Madera	--	--	--	--	--	1	1	6,069
Merced	--	--	1	--	--	6	7	36,718
Monterey	39	--	--	--	--	3	42	92,287
Orange	63	--	2	--	--	--	65	95,495
Sacramento	--	5	2	--	--	4	11	58,032
San Benito	--	--	--	--	--	1	1	985
San Bernardino	1	--	--	--	--	--	1	224
San Joaquin	2	6	4	--	2	6	20	184,547
San Luis Obispo	4	--	--	--	--	3	7	24,600
San Mateo	2	--	--	--	--	3	5	11,547
Santa Barbara	110	--	1	4	--	4	119	353,369
Shasta	--	--	--	--	--	1	1	5,521
Solano	--	19	16	--	1	15	51	299,894
Stanislaus	--	--	--	--	--	4	4	30,242
Sutter	--	2	1	--	1	7	11	49,816
Tehama	--	--	--	--	--	5	5	17,859
Tulare	2	--	1	1	--	--	4	4,253
Ventura	32	--	5	3	--	9	49	240,008
Yolo	--	9	6	--	6	26	47	270,424
Yuba	--	--	--	--	--	1	1	2,686
Other: Federal offshore	22	--	3	--	--	2	27	112,391
Total	1,804	58	103	29	18	186	2,198	5,827,626

¹ Development as defined by the American Petroleum Institute.

Source: American Petroleum Institute.

NONMETALS

Asbestos.—Shipments of asbestos in 1976, all from three mines, compared with two active mines in 1975, was 39% above and value of output was two and one-half times that of 1975. Calaveras Asbestos Corp., the major producer in 1976, which took over the Pacific Asbestos Corp. operations near Copperopolis, Calaveras County, began production late in 1975 but did not get into full production until April 1976. The operation had been inactive for 19 months prior to the takeover by Calaveras Asbestos. Other asbestos producers in 1976 included Union Carbide Corp., which operated the Santa Rita mine in San Benito County, and the Atlas Asbestos Co., which operated the Santa Cruz mine in Fresno County.

Barite.—No crude barite was mined in the State in 1976. A total of 121,000 tons of barite, three times that of 1975, was crushed and ground by three companies at three

mills in the State from out-of-State crude barite in 1976. Calcite Corp. operated the Rosamond mill in Kern County, FMC Corp. operated the Modesto mill in Stanislaus County, and Industrial Minerals Co. operated the Florin mill in Sacramento County. Most of the ground and crushed barite was sold or used for well drilling. The remainder was used in barium chemicals and glass.

Boron.—All of the boron produced in the United States was supplied by operations in California, and as in past years, most of it came from Kern County, with lesser quantities from San Bernardino and Inyo Counties. The State's total output was 6% greater in quantity and 16% greater in value compared with that of 1975.

The State's major producer, U.S. Borax & Chemical Corp., which operates an open pit mine and a processing plant at Boron, Kern County, and which continued to be the world's largest source of boron, continued its \$54 million expansion program to pro-

vide a 30% to 35% increase in output. The expansion program is planned for completion by mid-1977.

U.S. Borax has spent over \$1 million and will spend an additional \$2 million to build two new ponds for storing and evaporating waste water and tailings from refinery operations at Boron. One pond, circular in shape, 2,200 feet in diameter and 80 acres in area, is in service. The other, 100 acres in extent, is expected to be completed by the close of the year. The ponds are lined with a special high-density compacted clay to seal off sides and bottoms of the ponds to prevent borated liquids from seeping into the subsoil to protect the ground water.

Early in August, U.S. Borax placed a new electric shovel into service at the open pit mine at Boron. It has a 17-cubic-yard dipper, which is large enough to drive an automobile into it with the car doors open on both sides. It took 11 railroad flat cars to haul the disassembled parts to Boron from the factory and a crew of factory experts 40 days to assemble it. It weighs 600 tons and is powered by a 750-horsepower electric motor.

Because the demand for boric acid is expected to increase substantially in view of the strong growth projected for a large variety of end uses, including textile fiberglass, heat-resistant glass, cellulose insulation, and fire-resistant cotton batting. U.S. Borax completed facilities to increase boric acid capacity at the company's Wilmington refinery. This expansion, the first increase in boric acid capacity in the United States since 1962, was placed onstream in July 1976.

U.S. Borax installed two air-supported structures at the company's Boron operations. These structures, currently the largest in the United States, provide a cost-effective means of storing massive amounts of granular materials with minimum impact on the local environment. Especially designed to withstand winds up to 100 miles per hour, the two structures will eventually contain 100,000 tons of product in an area nearly the size of three football fields. The new storage capacity will enable the company to successfully meet periodic surges in world demand and are a part of a series of capital projects undertaken by the company to meet vigorous growth in the marketplace and to provide uninter-

rupted supplies of borates during peak demand periods.

Kerr-McGee Chemical Corp. continued to produce boron minerals from Searles Lake brines at its plants at Trona and Westend. The company was progressing on a \$100 million, 1.3-million-ton-per-year soda ash plant at Trona begun in 1974, but borax production will not be increased.

Tenneco Oil Co. continued to be a producer of colemanite and ulexite from an open pit mine, Kern Borate, in the Death Valley National Monument near the site of the old U.S. Borax town of Ryan, Inyo County. The colemanite ore was trucked 30 miles to a company calcining plant just over the California-Nevada border at Lathrop Wells, Nev. The ulexite ore from the mine was trucked 100 miles to a railroad siding at Dunn, where it was upgraded and marketed. Output was expanded significantly during 1976. At yearend, however, environmental concern for mining in the national parks prompted Congress to pass Public Law 94-429, which became effective in September 1976, and put surface disturbance restrictions on mining activities in the Death Valley National Monument. Tenneco sold its total boron mining and processing facilities in California and Nevada to American Borate Corp., which continued the operations.

A report on the borate deposits (colemanite and ulexite-probertite) in the Death Valley National Monument was published.¹⁶ The history of borate mining, general geology, active mines, and reserves and resources were described.

The major known deposits of colemanite and ulexite-probertite occur in Death Valley National Monument and the nearby Ryan area. Because of the Congressional legislation to limit or prohibit mining in the monument, deposits outside the monument have come under close scrutiny and reevaluation. The colemanite deposits near Kramer Junction, San Bernardino County, were examined and a report was published.¹⁷

Calcium Chloride.—Two companies produced calcium chloride from wells in San

¹⁶ Evans, J. R., G. C. Taylor, and J. S. Rapp. Mines and Mineral Deposits in Death Valley National Monument. Calif. Div. Mines and Geol., Spec. Rept. 125, 1976, pp. 21-33.

¹⁷ Evans, J. R., and T. Anderson. Colemanite Deposits near Kramer Junction, San Bernardino County, California. Calif. Div. Mines and Geol., Spec. Pub. 50, 1976, 8 pp.

Bernardino County, Leslie Salt Co. at its Amboy plant and National Chloride Co. of America at its Bristol Lake plant. Total output in 1976 was 15% above and value of production was 25% above that of 1975.

Cement.—Portland cement sales (shipments from mills) increased 8% and the total value of these sales increased 26% compared with that of 1975. Masonry cement sales increased 22% and the value increased 41% compared with that of 1975. Twelve plants, as in 1975, produced portland cement in the State and one plant, as in 1975, produced masonry cement. Eight of the 12 portland cement plants were in the southern California district and 4 were in the northern California district. The masonry cement plant was in the southern California district. Of the total portland cement sales, 70% was used by ready-mix concrete companies; 12%, by concrete products manufacturers; 10%, by building material dealers; 3%, by highway contractors; and the remaining 5%, by other contractors, government agencies, and miscellaneous customers. Of the total shipments of portland cement, 88% was shipped in bulk, and the remainder in containers.

During 1976, California Portland Cement Co. operated its Mojave and Colton cement plants; Kaiser Cement & Gypsum Corp. operated its Cushenbury and Permanente plants; Monolith Portland Cement Co. operated its Monolith plant; Amcord, Inc., operated its Oro Grande and Crestmore plants; The Flintkote Co. operated its San Andreas and Redding plants; Southwestern Cement Co. operated its Palos Robles plant; and Lone Star Industries, Inc., operated its Davenport plant.

Natural gas has in the past been the predominant fuel used for the cement kilns, but because of the higher cost of the natural gas and the possibility of an interruption in supply, many of the companies have or will be converting to coal. The California Public Utilities have stated that by 1979 there will virtually be no gas supplies

available for industry, with most of it going to residential, some small commercial users, and agriculture. Amcord, Inc., realized both energy and environmental benefits in converting cement kilns to coal.¹⁸

Raw materials consumed in manufacturing cement included 10.9 million tons of limestone, 379,000 tons of clay, 451,000 tons of shale, 18,000 tons of aluminum dross, 94,000 tons each of silica sand and quartz, 119,000 tons of iron ore, 367,000 tons of gypsum, 15,000 tons of anhydrite, and other miscellaneous materials.

A three-phase modernization was planned for the Kaiser Cement & Gypsum Corp.'s Permanente cement plant, which has been in operation since 1939 and has an annual capacity of 1.6 million tons. The first phase of modernization is expected to cost about \$50 million and encompass the replacement of four of the plants' six wet-process kilns with a smaller dry-process kiln equipped with preheater and precalciner. At the same time, the facility will be equipped to burn coal as its main fuel. The two remaining wet-process kilns would be replaced by a smaller, dry-process unit in the second phase, and the finish mill and customer service operations would be updated in the third phase. The conversion is expected to lower fuel consumption at Permanente by more than one-third. Plant emissions, as a result of the change, are expected to be about one-third the present level. About 2 years will be needed to complete the first phase after construction has begun. The program requires clearance from regulatory agencies.

The directors of Lone Star Industries, Inc., approved a program to improve and modernize their portland cement plant at Santa Cruz. The project, planned to be on-stream in 1979, incorporates a new roller mill, preheater system, and low-energy kiln, with extensive additional electrostatic precipitation equipment.

¹⁸ Rock Products. Coal and Cement, Partners in Production. February 1976, pp. 50-51.

Table 5.—California: Portland cement salient statistics
(Short tons)

	Northern California		Southern California		California total	
	1975	1976	1975	1976	1975	1976
Number of active plants	4	4	8	8	12	12
Production	2,214,020	2,376,896	4,996,633	5,514,593	7,210,663	7,891,489
Shipments from mills:						
Quantity	2,862,202	2,856,529	4,963,671	5,539,402	7,325,873	7,895,931
Value	\$77,072,946	\$92,016,764	\$156,477,123	\$201,629,622	\$232,550,069	\$293,645,366
Stocks at mills, Dec. 31	217,768	151,987	271,123	224,255	488,891	376,242

Clays.—Clays output was 2.3 million tons, including ball clay and bentonite, valued at \$13.6 million. It was produced by 43 companies from 71 pits located in 26 California counties. The average unit value of production was \$5.91 per ton compared with \$9.48 per ton in 1975. Of the total quantity of clays sold or used, 87% was common clay, 5% kaolin, 4% each bentonite and fire clay, and less than 1% ball clay. Major uses of clay were in manufacturing cement, common brick, face brick, sewer pipe, roof tile, pottery, lightweight aggregate, structural concrete, pet absorbent, foundry sand, refractories, and other products. Ten companies, in descending order of output—Lightweight Processing Co., Interpace Corp., The Flintkote Co. (Calaveras Cement), Pacific Clay Products Co., Amcord, Inc. (Riverside Cement), Homestake Mining Co. (Port Costa), Excel Mining Co., Lone Star Industries, Inc. (Pacific Cement), Crestlite Aggregates, Inc., and General Portland, Inc. (California division)—operated 24 mines in the State and produced 56% of California's total clay output in 1976.

Rather than close the company's century-old clay products operation at Lincoln, Placer County, and lay off the 220 employees, Interpace Corp. sold it to Pacific Coast Building Products, Inc., in February 1976. The new company operated the plant the remainder of the year under the original name of the operation, Gladding, McBean & Co. Interpace also sold its Corona, Orange County, clay pipe manufacturing facility to Pacific Coast Building Products, Inc., in midyear.

Diatomite.—Production of diatomite, all from four operations in Santa Barbara County, increased 9% in tonnage and 20% in output value compared with that of 1975. Johns-Manville Products Corp., Celite Div., and Grecco, Inc., both at Lompoc, continued to be the major producers. Airox Earth Resources, Inc., with a plant at Santa Maria, and Excel-Minerals Co., with operations at Taft, produced smaller quantities of diatomite. Most of the products from the Lompoc plants was sold or used for filtration, with the remainder used as insulation, fillers, and other miscellaneous uses. Most of the output from the Santa Maria and Taft plants was used for other miscellaneous purposes, but a small quantity was used as a lightweight aggregate.

The diatomite industry is essentially the business of selling microfossils of a wide variety of species. Once in a while a notable "outsider" fossil discovery occurs in the selective mining of diatomite. Quarry personnel at the Grecco, Inc., Dicalite Div. (Lompoc quarry), discovered the fossil skeleton of a 10- to 12-million-year-old baleen whale. The Los Angeles County Natural History Museum, curator of vertebrate paleontology, is supervising excavation and preservation of the fossil, which could prove to be about 80 feet long.¹⁹

Feldspar.—Crude feldspar produced in the State as a feldspar-silica mixture came from two operations, Calspar Corp., Ord Mountain mine, San Bernardino County, and Owens-Illinois, Inc., Pacific Grove mine, Monterey County. Output (feldspar content) decreased 43% in tonnage produced and increased 24% in total value compared with that of 1975. Nearly three-quarters of the output was used in glassmaking. The remainder was used in making sanitary and enamelware.

Gem Stones.—Jade minerals, jadeite and nephrite, occur at several places throughout the State, and gem or lapidary quality jade has been recovered in substantial amounts from several of these localities. Because there is a broad interest in jade, a report describing in detail a few of the best known and most significant occurrences of nephrite and jadeite in California was published.²⁰

Graphite (Manufactured).—Furnace production of synthetic graphite came from one company in Kern County—Great Lakes Carbon Corp., Antelope Valley plant—and three companies in Los Angeles County—Witco, Gardena plant; Polycarbon, Inc., North Hollywood plant; and Super Temp Co., Super Temp plant. Most was produced as electrodes but some was produced as anodes, crucibles and vessels, cloth and fibers, and other miscellaneous items.

Gypsum.—California ranked second to Michigan in crude gypsum mined but ranked first among the States in calcined gypsum produced in 1976. Crude gypsum output increased 14% in quantity and 25% in total value, and calcined gypsum production increased 43% in quantity and 35% in total value compared with that of 1975.

¹⁹ Coombs, G. Diatomite. *Min. Eng.*, March 1977, p. 58.

²⁰ California Division of Mines and Geology. *California Jade, A Collection of Preprints. Spec. Pub. 49, 1976, 53 pp.*

Crude gypsum was mined in the State at four operations—United States Gypsum Co. (Plaster City), Imperial County; Fannin-Superior Gypsum Co. (C. L. Fannin) and H. M. Holloway, Inc. (Lost Hills), Kern County; and Victor Material Co. (Amboy), San Bernardino County.

Calcined gypsum was produced at seven operations—California Gypsum Products, Inc., (Pabco), Alameda County; The Flintkote Co., Blue Diamond, (Fremont), Butte County; Kaiser Gypsum Co., Inc. (Antioch) and National Gypsum Co. (Richmond), Contra Costa County; United States Gypsum Co. (Plaster City), Imperial County; and Kaiser Gypsum Co., Inc. (Long Beach) and National Gypsum Co. (Long Beach), Los Angeles County. Byproduct gypsum was recovered and marketed by four operations—Collier Carbon & Chemical Corp. (Nichols), Contra Costa County; Valley Nitrogen Products Inc. (Helm), Fresno County; California Industrial Minerals Co. (Taylors), Madera County; and Occidental Petroleum Corp. (Lathrop), San Joaquin County.

Iodine.—Deepwater Chemical Co., Ltd., used out-of-State crude iodine to produce resublimed, potassium, sodium, ammonium, silver, and cuprous iodide and potassium, calcium, ammonium, and silver iodate inorganic compounds at its plant near Compton, Los Angeles County. Total output of iodine products was 50% greater than that of 1975.

Lime.—Output of lime increased 7% in tonnage and 25% in total value compared with that of 1975. Ten firms operated 15 plants in 12 counties in the State in 1976. Nearly two-thirds of the total output was produced by three firms—Kaiser Aluminum & Chemical Corp., Natividad plant (Monterey County); Holly Sugar Corp., Hamilton plant (Glenn County), Brawley plant (Imperial County), Santa Ana plant (Orange County), and Tracy plant (San Joaquin County); and Kerr-McGee Chemical Corp., Westend plant (San Bernardino County). The Flintkote Co., U.S. Lime Div., produced lime at its Richmond plant (Contra Costa County) and at its City of Industry plant (Los Angeles County). Amstar Corp. operated lime plants at Spreckels (Monterey County) and at Woodland (Yolo County). Other lime producers included the Diamond Springs Lime Co., Diamond Springs plant (El Dorado

County); Pfizer, Inc., Manufacturing Div., Lucerne plant (San Bernardino County); Union Sugar Co., Betteravia plant (Santa Barbara County); and American Crystal Sugar Co., Clarksburg plant (Yolo County). Ninety-three percent of the lime was produced as quicklime and the remainder as hydrate. Lime was used for precipitating magnesia from seawater, sugar refining, soil stabilization, refractories, and other miscellaneous minor applications.

A report on the lime industry in California was published²¹ describing the processing, use, and supply and demand of lime.

Lithium Compounds.—Kerr-McGee Chemical Corp., the State's only lithium producer, recovered lithium carbonate by flotation from dilithium sodium phosphate from Searles Lake brines at Trona, San Bernardino County. Output was below that of 1975, but value of output was nearly double. Although the company treatment plant at Trona is being expanded, the company does not plan to increase lithium capacity at this operation.

Magnesium Compounds.—Magnesium compounds production declined 7% and 9%, respectively, in quantity and value of output compared with that of 1975. Kaiser Aluminum & Chemical Corp., Refractories Div., continued to be the major producer at its Moss Landing seawater plant in Monterey County. Products from this plant were refractory magnesia, magnesium hydroxide, and caustic-calcined magnesia. Merck & Co., Inc., produced extra-light, light, and heavy magnesium oxide and magnesium hydroxide, trisilicate, and carbonate from seawater bitters in San Mateo County. FMC Corp., Inorganic Chemical Div., produced magnesium chloride crystal and brines (33%) at its plant in San Diego County until March 29, when Western Magnesium Corp. purchased and operated it throughout the remainder of the year producing magnesium chloride crystal.

Perlite.—Crude perlite mined in the State and sold or used in 1976 was produced by American Perlite Co., Redco, Inc., at the Fish Springs mine near Big Pine in Inyo County. Eight companies, four with plants in Los Angeles County, two in San Diego County, and one each in San Bernardino and Sonoma Counties, expanded perlite. A total of 27,359 tons of expanded perlite

²¹ Rapp, S. Lime Industry in California. California Div. Mines and Geol., Calif. Geol., October 1976, pp. 219-223.

was produced, 12% more than that of 1975. Of the total quantity sold or used, 40% was used as a filter aid, 26% as a horticultural and agriculture aggregate, 22% as a construction aggregate, and the remaining 12% for other miscellaneous uses.

Phosphate Rock.—A small production of phosphate rock was reported from the Cuyama mine in Santa Barbara County by the California Phosphate Co. Reportedly, the phosphate rock was produced and used as mined without treatment as a soil additive.

An economic evaluation of the Pine Mountain phosphate deposit, Ventura County, was published.²² Mining of this deposit in the Los Padres National Forest, about 50 miles north of Los Angeles, by United States Gypsum Co. has been under consideration by BLM since a 2-year prospecting permit was issued to United States Gypsum in November 1964 with the approval of the U.S. Forest Service. In October 1966, the permit was extended for a 3-year period, and in April 1969, the company filed an application for a preference right lease.

A draft Environmental Impact Statement (EIS) on the proposed mining was submitted to the President's Council on Environmental Quality by BLM in July 1971. A final EIS was issued in June 1976. Public hearings have been held at each stage in the process. The area of the deposit in the proposed 2,435-acre phosphate lease is environmentally sensitive. Government agencies and citizens have been concerned because the California condor nests in the Sespe Condor Sanctuary about 30 miles to the southeast, because haul trucks from the

proposed mine would increase traffic on State Highway 33, and because mining may affect the scenic beauty and recreational possibilities of the area.

Potassium Salts.—Output of potassium salts, all from the Kerr-McGee Chemical Corp. operation at Trona, San Bernardino County, was 3% greater in quantity as measured in K_2O equivalent, but 20% less in total value of product compared with that of 1975. Marketed products were potassium sulfate, which contained 51.3% K_2O equivalent, and standard, coarse, and chemical muriate, which contained 61.2%, 61.2%, 63.1% K_2O equivalent, respectively.

Pumice.—Combined output of crude and prepared pumice more than doubled in quantity and increased 17% in total value compared with that of 1975. Material sold and used as crude and prepared pumice included pumice, pumicite (ash), volcanic tuff, scoria, and volcanic cinder. It was produced by 32 operators from 76 mines in 14 counties and processed at 19 plants. Nearly three-quarters of the total output came from four counties: Lake, Lassen, Modoc, and Siskiyou. Other major producing counties were Inyo, Plumas, San Bernardino, and Shasta. The material was used for road construction (65% of the total), concrete aggregate (12%), landscaping (10%), roofing granules (7%), railroad ballast (2%), and other uses (4%) including abrasives, building veneer block, soil conditioner, pesticide carrier, fill material, and concrete admixture.

²² Evans, J. R. Economic Evaluation of Pine Mountain Phosphate Deposit, Ventura County, Calif. Calif. Div. Mines and Geol., Calif. Geol., December 1976, pp. 275-279.

Table 6.—California: Pumice sold or used by producers in 1976, by county ¹

County	Crude		Prepared		Total	
	Quantity (short tons)	Value	Quantity (short tons)	Value	Quantity (short tons)	Value
Inyo -----	--	--	W	W	W	W
Kern -----	--	--	1,205	W	1,205	W
Lake -----	--	--	W	W	W	W
Lassen -----	151,785	\$89,080	--	--	151,785	\$89,080
Madera -----	--	--	W	W	W	W
Modoc -----	102,072	64,090	10,000	\$10,000	112,072	74,090
Mono -----	--	--	W	W	W	W
Napa -----	330	550	--	--	330	550
Plumas -----	38,035	22,820	--	--	38,035	22,820
San Bernardino -----	--	--	W	W	W	W
Shasta -----	W	W	W	W	W	W
Siskiyou -----	51,826	58,132	77,365	397,300	129,191	455,432
Tehama -----	W	W	--	--	W	W
Ventura -----	W	W	--	--	W	W
Undistributed -----	40,647	52,223	231,792	2,550,788	272,439	2,603,016
Total -----	384,695	286,900	320,362	2,958,088	705,057	3,244,988

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
¹ Includes pumicite, scoria, volcanic cinder, and tuff.

Salt.—Salt output increased 2% in quantity and 7% in total value compared with that of 1975. All of the salt sold or used in California in 1976 was produced as evaporated salt except for a small quantity of rock salt produced by Leslie Salt Co. in San Bernardino County and small quantities of brine produced by Imperial Thermol Products, Inc., in Imperial County and by Occidental Petroleum Chemical Co. in San Bernardino County. All of the salt produced by evaporation was recovered by using the solar evaporation process except for a small quantity recovered by the vacuum pan process by Leslie Salt Co. in Alameda County. Leslie Salt Co., with operations in Alameda, Napa, San Bernardino, and San Mateo Counties, was the State's leading salt producer. Other salt producers were Western Salt Co., with operations in Kern and San Diego Counties; Occidental Petroleum Chemical Co., Pacific Salt and Chemical Co., Southwest Salt Co., and Standard Salt Co. in San Bernardino County; Oliver Bros. Salt Co. in Alameda County; and Imperial Thermol Products, Inc., in Imperial County.

The rock salt operations of Leslie Salt Co. at Amboy were terminated at the end of 1976, but this plant will continue as a calcium chloride producer with some by-product solar salt for the Food Div. The company plants at Newark, Redwood City, and Napa adjacent to San Francisco Bay, produced salt by natural solar evaporation and have a total capacity in excess of 1 million tons per year.

Sand and Gravel.—California continued to be the Nation's leading State in terms of quantity and value of sand and gravel output in 1976. Production increased 9% in tonnage and 20% in total value of output compared with that of 1975. Production was 97 million tons valued at \$202 million in 1976. More than 98% of this total was sold and used as construction grade and less than 2%, industrial. Of the construction sand and gravel sold or used, 42% was used as concrete aggregate, 20% as asphaltic concrete aggregates and other bituminous mixtures, 19% for roadbase and coverings, 10% for concrete products, 7% for fill, and 2% for other miscellaneous uses. In 1976, 390 operators produced construction sand and gravel in the State; 6 operators produced industrial sand and gravel; and 10 operators produced both construction and industrial sand and gravel for a total of 406 operators. Production was reported from 52 of the State's 58 counties. Seventeen operators, each with an output of 1 million tons or more, accounted for 32% of the State's total for construction sand and gravel. An additional 42 operators, each with an output of 500,000 tons but less than 1 million tons, accounted for an additional 31% of the State's total. The leading 10 producers, in descending order of output, were Conrock Co.; Lone Star Industries, Inc.; Owl Rock Products Co.; Livingston & Graham, Inc.; Kaiser Industries Sand & Gravel; Blue Diamond Materials; A. Teichert & Son, Inc.; C. L. Pharris Trucking; Transit Mix Concrete; and

Rhodes and Jamison. Together, they accounted for 47% of the construction sand and gravel produced in the State in 1976.

Lone Star Industries, Inc., announced in September that the firm had agreed to purchase 1,473 acres of land in the Rancho Cordova area, Sacramento County, from Aerojet General Corp. as the site of a \$12 million sand and gravel plant. It will replace an existing plant at Bridge Street in Fair Oaks, Sacramento County. Lone Star will obtain its sand and gravel from mile-long windrows of gold dredge tailings 15 to 25 feet high. More recently, the property adjacent to Mather Air Force Base was used by Aerojet for missile testing. The use permit granted by Sacramento County contains 22 conditions covering air and water pollution control, noise control, safety fencing, visual screening, land rehabilitation, and other factors. The company estimated the property contains 45 million tons of sand and gravel or about a 30-year supply at expected rates of production.

A study of the aggregates in the greater Los Angeles area, sponsored by a grant from the Federal Bureau of Mines and conducted by the California Division of Mines and Geology (CDMG) was begun in 1975 and completed in 1976. A report²³ on the findings was placed on open file and available for public examination in the Los Angeles, San Francisco, and Sacramento district offices of the CDMG. The report is to be published in 1977. The study was designed to furnish the aggregate supply-demand data needed for developing land-use plans that will allow for an orderly supply of aggregate for posterity.

A similar 1-year study of the aggregate in the San Francisco Bay area, also sponsored by a grant from the Federal Bureau of Mines and conducted by the CDMG, was begun in mid-1976 and will be completed in mid-1977.

²³ Evans, J. R., T. P. Anderson, M. W. Manson, R. L. Maud, W. B. Clark, and D. L. Fife. Aggregates in the Greater Los Angeles Area, Calif. Div. Mines and Geol., OFR 77-1 LA, 1976, 243 pp.

Table 7.—California: Construction and industrial sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1976		
	Quantity	Value	Value per ton
Construction:			
Sand -----	45,344	84,004	1.85
Gravel -----	49,420	106,914	2.16
Total ¹ -----	94,765	190,918	2.01
Industrial:			
Sand -----	1,802	11,288	6.26
Gravel -----	25	67	2.68
Total -----	1,827	11,355	6.22
Grand total ¹ -----	96,592	202,272	2.09

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

Table 8.—California: Construction sand and gravel sold or used by major use category

(Thousand short tons and thousand dollars)

Use	1976		
	Quantity	Value	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	39,586	82,279	2.08
Concrete products (cement blocks, bricks, pipe, etc.)	9,511	19,989	2.10
Asphaltic concrete aggregates and other bituminous mixtures	19,276	42,287	2.19
Roadbase and coverings	17,707	32,144	1.82
Fill	6,667	9,014	1.35
Other uses	2,015	5,205	2.58
Total	¹ 94,765	190,918	2.01

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

Sodium Compounds.—Combined production of sodium carbonate (soda ash) and sodium sulfate (salt cake) decreased 5% in total quantity but increased 19% in total value of output compared with that of 1975. Kerr-McGee recovered both chemical products from Searles Lake brines at its Trona and Westend plants in San Bernardino County.

Kerr-McGee Searles Lake Trona operations are being expanded to increase soda ash production from 150,000 to 1.3 million tons per year. Borax production will not be increased. The expansion is based on a pilot plant operation for carbonating brine using powerplant and lime kiln flue gases. Feed for the plant expansion will come from deep wells in Searles Lake rather than from the shallow wells which provided feed for the company's Trona and Westend plants. The company was also increasing capacity for natural sodium sulfate production by 150,000 tons per year at Trona. Completion of the project was scheduled for 1977.

Stone.—Stone production, including 12,600 tons of dimension stone valued at

\$804,000 and 32.4 million tons of crushed and broken stone valued at \$74.5 million, decreased 2% in total tonnage but increased 4% in value compared with that of 1975. Seventeen companies quarried dimension stone at 25 quarries for rough construction, rubble, finished monumental and construction stone, and other uses. Leading dimension stone producers were National Quarries Co. and Santa Maria Stone Co.

A total of 98 companies produced crushed and broken stone from 520 quarries in the State for cement, roadbase aggregate, bituminous aggregate, and other uses. Leading producers were Kaiser Cement & Gypsum Co., the U.S. Forest Service, and Amcord, Inc. Of the total shipments of crushed and broken stone, 78% was transported to market by truck, 5% by railroad, and the remaining 17% by waterway and other unspecified methods. One-third of the total crushed and broken stone shipments came from seven of the major producing quarries, each with an output exceeding 900,000 tons. An additional 31% of the total came from 15 quarries, each with an output greater than 500,000 tons.

Table 9.—California: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975		1976	
	Quantity	Value	Quantity	Value
Dimension:				
Limestone and dolomite -----	3	W	3	70
Granite -----	6	377	5	539
Sandstone, quartz, and quartzite -----	(¹)	11	1	18
Slate -----	(¹)	9	W	W
Traprock -----	(¹)	1	W	W
Other stone -----	5	93	7	127
Total ² -----	11	490	13	804
Crushed and broken:				
Limestone and dolomite -----	16,576	36,532	14,800	33,298
Granite -----	4,300	10,378	5,146	13,214
Marble -----	³ 15	³ 174	W	W
Sandstone, quartz, and quartzite -----	3,451	7,856	3,413	7,429
Traprock -----	4,390	8,617	3,967	9,165
Other stone -----	4,409	8,693	5,038	11,442
Total ² -----	33,141	72,251	32,364	74,548
Grand total ² -----	33,152	72,740	32,377	75,352

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

¹ Less than ½ unit.

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

³ Data include shell.

Table 10.—California: Stone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension:				
Rough stone:				
Rough blocks -----	3	224	(1)	(1)
Construction -----	4	80	6	(2)
Flagging -----	(1)	(1)	(1)	(1)
Other rough stone -----	1	15	2	195
Dressed stone:				
Architectural -----	2	124	(2)	(2)
Construction -----	--	--	2	288
Flagging -----	(3)	14	(2)	(2)
Slate -----	--	--	(3)	10
Other dressed stone ⁴ -----	1	34	3	311
Total ⁵ -----	11	490	13	804
Crushed and broken:⁶				
Cement manufacture -----	11,240	18,800	10,530	18,470
Dense-graded roadbase stone -----	6,971	13,980	5,600	11,760
Bituminous aggregate -----	3,525	9,483	3,034	8,718
Roadstone -----	2,164	4,395	2,960	5,338
Concrete aggregate -----	2,696	5,660	2,815	6,070
Riprap and jetty stone -----	1,126	2,752	1,892	5,287
Lime manufacture ⁷ -----	785	2,371	1,458	4,005
Fill -----	1,460	2,283	894	1,391
Roofing granules -----	677	1,352	753	1,672
Glass -----	292	2,128	416	3,010
Macadam aggregate -----	299	763	384	1,035
Other filler -----	290	1,948	201	1,434
Terrazzo and exposed aggregate -----	110	781	141	1,243
Mineral food -----	81	661	114	780
Whiting -----	92	1,252	102	1,370
Bedding material -----	103	185	77	252
Filter stone -----	73	206	54	131
Agricultural limestone -----	51	285	35	194
Surface treatment aggregate -----	124	213	31	50
Abrasives -----	--	--	(8)	(8)
Flux stone -----	5	17	(8)	(8)
Other uses ⁹ -----	980	2,734	867	2,336
Total ⁵ -----	33,141	72,251	32,364	74,548
Grand total ⁵ -----	33,152	72,740	32,377	75,352

¹ Included with "Other rough stone."

² Included with "Other dressed stone."

³ Less than 1/2 unit.

⁴ Includes stone for monumental purposes and curbing.

⁵ Data may not add to totals shown because of independent rounding.

⁶ Includes limestone, miscellaneous stone, traprock, granite, sandstone, marble, and shell.

⁷ Includes dead-burned dolomite and sugar refining.

⁸ Included with "Other uses."

⁹ Includes stone used for railroad ballast, ferrosilicon, carbon dioxide (1975), asphalt filler (1976), soil conditioning, refractory stone, building products (1975), drain fields (1975), and abrasives (1976).

Sulfur.—Byproduct sulfur was recovered at 14 petroleum refineries—4 in Contra Costa County, 9 in Los Angeles County, and 1 in Solano County. The Union Oil Co. of Calif., Oleum refinery, Contra Costa County, was the leading producer, followed by Standard Oil Co. of Calif., Richmond refinery in Contra Costa County; Mobil Oil Corp., Torrance refinery; Chevron U.S.A., Inc., El Segundo refinery; and Atlantic Richfield Co., Watson refinery, all in Los Angeles County; Exxon Co., U.S.A., Benicia refinery in Solano County; and Texaco, Inc., Long Beach refinery in Los Angeles County.

Total production and sales of sulfur was 432,000 long tons valued at \$7.9 million in 1976, compared with a production of 395,000 long tons and sales of 375,000 long tons valued at \$6.9 million in 1975.

Two companies—Leon Oil Co. at its Avon plant near Martinez, Contra Costa County, and Shell Oil Co. at its Wilmington plant in Carson, Los Angeles County—recovered and marketed hydrogen sulfide in 1976.

Talc, Soapstone, and Pyrophyllite.—Mine production declined 63% compared with that of 1975, but the value of output

was only 5% below that of 1975 because of the increased unit value of the product. Production was reported from 10 mines—1 in El Dorado County, 5 in Inyo County, and 4 in San Bernardino County. The recorded producers in the State were Pfizer, Inc., Bonnie, White Eagle and Eclipse mines in the Death Valley National Monument, Inyo County; Pfizer, Inc., Apex and Acme mines in San Bernardino County; Cyprus Mines Corp., Panamint mine and Standard Industrial Minerals White Eagle mine in Inyo County; Huntington Tile Co., Omega and Yucca mines in San Bernardino County; and Commercial Minerals Co., Docs mine in El Dorado County. Mined material was sold to grinders or consumers or ground by the producers. One such grinder, Industrial Minerals and Chemical Co., purchased talc and ground it in its plant in Sacramento County. Ground and prepared material was used or sold for use in ceramics, paints, refractories, paper, and other miscellaneous uses. Some of the products were exported out of the State and out of the country.

A report covering the talc mines and deposits in Death Valley National Monument was published.²⁴ The history of talc mining, uses, general geology, and active mines in this area were described. A report on the geologic features of Death Valley was also published.²⁵

Vermiculite.—Production and sales of exfoliated vermiculite, derived from crude vermiculite produced in Montana and South Carolina, was 50% above that of 1975, but the total value of sales declined 7% below that of 1975. W. R. Grace & Co., with exfoliation plants at Newark (Alameda County), Los Angeles (Los Angeles County), and Santa Ana (Orange County), and La Habra Products, Inc., with a plant in Anaheim (Orange County) were the State's producers in 1976. Consumption by end use was 36% for fireproofing, 30% for concrete aggregate, 16% for soil conditioning, 8% for loose fill insulation, 5% for horticulture, 2% for plaster aggregate, and the remaining 3% for block insulation and other miscellaneous uses.

METALS

Gold, Silver, Copper, Lead, and Zinc.—The total value of mine production (recoverable) of gold, silver, copper, lead, and zinc in the State was \$2.2 million, com-

pared with \$2.5 million in 1975, a 12% decline. Production of these metals was recorded from 12 lode mines, 2 each in Shasta and Sierra Counties, and 1 each in Alpine, Inyo, Los Angeles, Mono, Plumas, Sacramento, Tuolumne, and Yuba Counties, compared with 10 active mines in 1975. Gold and silver production was recorded from four placer mines, one each in Del Norte, Trinity, Mono, and Yuba Counties. Gold and silver was also recovered as a by-product of washing sand and gravel to produce construction aggregate at three operations in Fresno County, two operations each in Sacramento and Stanislaus County, and one each in Merced, San Joaquin, and Shasta Counties.

Gold production increased 8% compared with that of 1975, but the total value declined 16% because of the drop in the unit value of gold. Of the total quantity of gold produced, 53% was recovered from lode material and the remainder from placer material. The State's leading gold producer was the Oriental mine in Sierra County, operated by the Dickey Exploration Co. The second largest producer was the Yuba Goldfields, Inc., which operated a bucket-line dredge on a test basis on placer ground at Hammonton near Marysville in Yuba County. The dredge operated, Old No. 21, was one of several dredges operated on this 10,400-acre property along the Yuba River by Yuba Consolidated Goldfields, Inc., during the period 1905-68 when more than \$100 million in gold was recovered. Dredging was suspended in June 1976, about a year after operations were begun, reportedly to obtain statistical cost data that would be valuable in assessing possible future operations. As reported, the operations were suspended because income was insufficient to meet operating costs, reflecting reduced gold recoveries and a decline in gold prices.

Silver production declined 29% in quantity and value of output compared with that of 1975. Major producers of silver were: Union Carbide Corp., as a coproduct from tungsten ore produced at the Pine Creek mine in Inyo County; Claude B.

²⁴ Evans, J. R., G. C. Taylor, and J. S. Rapp. *Mines and Mineral Deposits in Death Valley National Monument, California*. Calif. Div. Mines and Geol., Spec. Rept. 125, 1976, pp. 35-59.

²⁵ Troxel, B. W., and L. A. Wright. *Geologic Features Death Valley, California*. Calif. Div. Mines and Geol., Spec. Rept. 106, 1976, 72 pp.

Lovestedt, as a coproduct from gold-silver ore from the Zaca mine in Alpine County; and the Montecito Mining Co., as a coproduct for zinc ore produced from the Thompson-Darwin mine in Inyo County.

Copper production increased 9% in quantity and 18% in total value compared with that of 1975. Union Carbide Corp., with operations at the Pine Creek tungsten mine in Inyo County, was by far the principal producer in the State. Smaller quantities of copper were recovered by the Stauffer Chemical Co., by precipitating copper from mine drainage water from the Iron Mountain mine in Shasta County and by Montecito Mining Co., as a coproduct from zinc ore produced from the Thompson-Darwin mine in Inyo County.

Lead production dropped 18% in quantity and 11% in value compared with that of 1975. Most of the lead was produced by Montecito Mining Co. from the Thompson-Darwin mine. Cannon Resources Ltd., the second largest producer, recovered lead as a coproduct from gold-silver ore from the Eva Bell mine in Mono County.

Zinc production declined 17% in quantity and 22% in value compared with that of 1975. Montecito Mining Co., with operations at the Thompson-Darwin zinc mine, was the principal producer, followed by Cannon Resources Ltd., with operations at the Eva Bell gold-silver mine, and Claude B. Lovestedt, with operations at the Zaca gold-silver mine.

Table 11.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing ¹		Material sold or treated ² (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1974, total	10	4	5,689	5,049	\$806,528	41,894	\$197,324
1975, total	10	6	29,200	9,606	1,551,270	79,757	352,527
1976:							
Del Norte	--	1	--	5	627	--	--
Fresno	--	--	--	428	53,637	60	261
Merced	--	--	--	23	2,882	1	4
San Joaquin	--	--	--	148	18,547	13	57
Shasta	2	--	151	80	10,026	368	1,601
Sierra	2	--	3,766	4,174	523,086	998	4,342
Stanislaus	--	--	--	627	78,576	62	270
Trinity	--	1	--	15	1,880	--	--
Tuolumne	1	--	10	7	877	--	--
Undistributed ³	7	2	6,286	4,885	612,189	55,763	242,569
Total	12	4	10,213	10,392	1,302,327	57,265	249,104
Copper							
Lead							
Zinc							
	Short tons	Value	Short tons	Value	Short tons	Value	Total value
1974, total	194	\$299,800	35	\$15,706	8	\$5,630	\$1,324,988
1975, total	344	441,151	66	23,186	206	160,763	2,533,897
1976:							
Del Norte	--	--	--	--	--	--	627
Fresno	--	--	--	--	--	--	53,898
Merced	--	--	--	--	--	--	2,882
San Joaquin	--	--	--	--	--	--	18,504
Shasta	62	86,762	(4)	34	--	--	99,423
Sierra	--	--	--	--	--	--	527,423
Stanislaus	--	--	--	--	--	--	78,846
Trinity	--	--	--	--	--	--	1,880
Tuolumne	--	--	--	--	--	--	877
Undistributed ³	312	434,784	54	24,903	170	125,924	1,440,369
Total	⁵ 375	521,546	54	24,987	170	125,924	2,223,838

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

² Does not include gravel washed.

³ Alpine, Inyo, Los Angeles, Mono, Plumas, Sacramento, and Yuba Counties combined to avoid disclosing company proprietary data.

⁴ Less than 1/2 unit.

⁵ Data do not add to total shown because of independent rounding.

Table 12.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation -----	2,713	625	--	--	--
Smelting of concentrates ¹ -----	2,746	54,124	311	47	165
Direct smelting of ore and copper precipitates ² -----	86	2,353	63	7	5
Total lode material -----	5,545	57,102	³ 375	54	170
Placer -----	4,847	163	--	--	--
Grand total -----	10,392	57,265	375	54	170

¹ Includes byproduct recovery from tungsten ore.

² Combined to avoid disclosing company proprietary data.

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

Table 13.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, 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 (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold -----	6	5,536	5,005	1,279	(³)	(³)	(³)
Gold-silver -----	2	2,225	440	15,657	1	--	6
Silver, zinc, and tungsten ⁴ -----	3	⁵ 2,350	100	40,166	311	46	164
Total ⁶ -----	11	10,111	5,545	57,102	312	54	170
Other lode material:							
Copper precipitates -----	1	102	--	--	62	--	--
Total lode material ⁶ -----	12	10,213	5,545	57,102	375	54	170
Placer -----	4	--	4,847	163	--	--	--
Grand total -----	16	10,213	10,392	57,265	375	54	170

¹ Operations from which gold and silver are recovered as byproduct from sand and gravel operations and copper recovered as byproduct from tungsten operations are not counted as producing mines.

² Does not include gravel washed.

³ Less than ½ unit.

⁴ Combined to avoid disclosing company proprietary data.

⁵ Excludes tungsten ore tonnage.

⁶ Data may not add to totals shown because of independent rounding.

Iron Ore and Concentrates.—Usable iron ore shipments to consumers, which include direct shipping ore, concentrates, and agglomerates, increased 4% in quantity and 13% in total value compared with that of 1975. Kaiser Steel Corp. was the major producer. Concentrates and agglomerates were recovered from ore produced at its Eagle Mountain mine in Riverside County and shipped by rail to its steel plant at Fontana in San Bernardino County. California Portland Cement Co. produced a small quantity of direct shipping ore from the Baxter mine in San Bernardino County for use in cement manufacturing. Standard Slag Co.

produced ore and shipped concentrate from the Beck mine and mill in San Bernardino County.

Iron Oxide Pigments.—Pfizer, Inc., produced synthetic brown, red, and yellow iron oxides and mixtures of synthetic and natural iron oxides at its Emeryville plant, Alameda County. Total output was 18% above that of 1975.

Iron and Steel.—Production and shipments of pig iron each increased 5% and the total value of shipments increased 29%, compared with that of 1975. The average value per ton increased \$16 or 23% compared with that of 1975.

Western steel market receipts, which comprises the number of tons shipped by steel mills, both domestic and foreign, to customers in the seven Western States of California, Oregon, Washington, Nevada, Arizona, Utah, and Idaho, increased 8% to 7,982,000 tons in 1976, up about 600,000 tons from 71,412,000 tons in 1975. The 8% increase in the West, disappointing for a recovery year after a deep slump, compares with a 14% increase in the national steel market.²⁶

Kaiser Engineers is providing design and construction management services for a \$233 million modernization program at Kaiser Steel Corp.'s Fontana steel mill. The project involves construction of a two-vessel basic oxygen plant, with provisions for a third vessel, to replace existing open-hearth furnaces. It also calls for a 700,000-ton-per-year continuous slab caster. The new basic oxygen shop is scheduled to go into operation early in 1978, increasing the plant's annual capacity from 3.4 million ingot tons to 3.6 million tons. Kaiser Engineers designed the original steel mill at Fontana and has been involved in four subsequent expansions.

Kaiser Steel Corp. announced it will spend \$60 million during the next 4 years on environmental control equipment to bring its Fontana production facility into compliance with the Federal Clean Air Act. Specifically at issue are the plant's coke ovens and the amount of sulfur content emitted in the production of the steel forged there.

Mercury.—Mercury production in 1976 had another drastic decline as it did in 1975. Mine production in the State was reported from five mines: Aetna (operated by Lansome Mining Co.), Knoxville (Morgan North Mine Management), Manhattan-One Shot (One-Shot Mining Co.), and Oat Hill (W. T. Kritikos), all open pit operations in Napa County, and New Almaden (Santa Clara Quicksilver Co.) underground operations in Santa Clara County. Most of the mercury produced was marketed through Quicksilver Producers Inc., of San Francisco. The average annual quoted price for mercury at New York was \$121.30 per flask.

Molybdenum.—Production of molybdenum, recorded as the molybdenum content of combined molybdenum oxide and sulfide concentrates shipped during the year, nearly doubled that of 1975. The en-

tire amount was recovered as a byproduct of tungsten ore produced from the Pine Creek mine near Bishop in Inyo County by Union Carbide Corp. The concentrates were produced in Union Carbide's plant at the mine.

Nickel.—Deposits of low-grade nickeliferous iron laterites are known in northwestern California near the Oregon border. Pine Flat Mountain, northwest of Crescent City, is probably the best known district. The largest resource in California is in the Little Red Mountain district in Mendocino County. A process is under development by the Federal Bureau of Mines at its Albany, Oreg., Metallurgy Research Center to recover nickel from domestic laterites such as those in California and Oregon that reportedly have resources totaling 565,000 short tons of nickel. The process which has significant advantages over the Nicaro, Cuba, procedure and modifications thereof, incorporates selective reduction roasting and an oxidizing ammonia-ammonium sulfate leach with solvent extraction and electrowinning to recover nickel in cathode form. Cobalt and copper are also recovered in cathode form and zinc, if present, is recovered as zinc sulfate.

Rare-Earth Minerals.—Molycorp, Inc., continued to produce most of the Nation's output of rare-earth oxides (REO) contained in concentrates at its mine located at Mountain Pass, San Bernardino County. Production in all product forms from this operation in 1976 was down 13% from that of 1975.²⁷ Bastnäsite is mined from an open pit deposit and concentrated in a 30,000-ton-per-year mill on the property. Three grades of bastnäsite are produced: 60% REO unleached, 70% REO leached, and 90% REO calcined. Processed concentrate of cerium (65% CeO₂) and lanthanum (75% LaO₃) are shipped. An electronic-nuclear-phosphor grade of pure europium oxide also is produced at this location. The Mountain Pass operation also provides concentrates of neodymium-praseodymium and gadolinium-samarium when required, and ships bastnäsite concentrates to other Molycorp plants at Louviers, Colo., York, Pa., and Washington, Pa.

²⁶ Kaiser Steel Corporation. *Western Steel Market 1976-77*. 1976, 4 pp.

²⁷ Cannon, G. J. *Rare Earths. Eng. and Min. J.*, March 1977, p. 183.

The last two units in Molycorp's recent expansion program at the Mountain Pass processing complex were completed in early 1976. The 200-ton-per-day bastnäsite thickening-filtering-drying section at the mill has begun processing material from the flotation section, and the final 4.5-million-Btu concurrent lanthanum concentrate dryer at the chemical plant became fully operational. As a result, Molycorp is now geared for anticipated increases in demand for rare-earth catalysts in petroleum and petrochemical refining and in air pollution control, as well as for rare-earth ferroalloys for metallurgical use.

Tungsten.—Nearly all of the Nation's recorded production of tungsten contained in tungsten ore and concentrates came from California mines. The State's tungsten production increased 9% in quantity and 29% in total value compared with that of 1975. Most of the State's production came from the Pine Creek mine near Bishop, Inyo County, operated by Union Carbide Corp. Small tonnages of ore and concentrates were shipped from 17 other tungsten mines in the State in 1976. These mines were located in Fresno, Inyo, Kern, Los Angeles,

Madera, San Bernardino, San Diego, and Tulare Counties. Some of this ore may have been mined in previous years. Most of the ore and concentrate shipped in 1976 was sent to the Union Carbide Corp. plant at Pine Creek or to the Kennametal, Inc., plant, Churchill County, Nev., for upgrading to a marketable product.

Plans were being made for concentrates from the Union Carbide's Tempiute mine and mill near Alamo, Nev., set for completion in mid-1977, to be delivered to Union Carbide's Pine Creek, Bishop, facility for conversion to ammonium paratungstate (APT). Wah Chang continued development work at the Strawberry mine, Tuolumne County.

Uranium.—Uranium exploration activity was continued in the State in 1976. Most of the larger energy companies have been involved in property appraisal or acquisition in California within the past 5 years. The principal areas of interest are the Petersen Mountains, Lassen County; Sonora Pass, Tuolumne County; Coso Range, Inyo County; the Taft-McKittrick area, Kern County; and the Mojave Desert, Kern, San Bernardino, and Riverside Counties.

Table 14.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Atlas Asbestos Co -----	Box 805 Coalinga, Calif. 93210	Open pit mine ----	Fresno.
Calaveras Asbestos Corp ..	Box 127 Copperopolis, Calif. 95228	----do -----	Calaveras.
Boron minerals and compounds:			
U.S. Borax & Chemical Corp. ¹	Box 75128 Sanford Station Los Angeles, Calif. 90005	----do -----	Inyo and Kern.
Calcium chloride:			
National Chloride Co. of America.	615 South Flower St. Suite 803 Los Angeles, Calif. 90017	----do -----	San Bernardino.
Carbon dioxide (natural):			
Standard Oil Co. ²	225 Bush St. San Francisco, Calif. 94120	Plant -----	Kern.
Cement:			
Amcord, Inc. ³ -----	610 Newport Center Dr. Newport Beach, Calif. 92660	Plants -----	Riverside and San Bernardino.
California Portland Cement Co. ⁴	800 Wilshire Blvd. Los Angeles, Calif. 90017	----do -----	Kern and San Bernardino.
The Flintkote Co. ⁵ -----	San Francisco, Calif. 94104	----do -----	Calaveras and Shasta.
General Portland, Inc -----	3810 Wilshire Blvd. Los Angeles, Calif. 90005	Plant -----	Kern.
Kaiser Cement & Gypsum Corp. ⁴	300 Lakeside Dr. Oakland, Calif. 94612	Plants -----	San Bernardino and Santa Clara.
Monolith Portland Cement Co.	3326 San Fernando Rd. Los Angeles, Calif. 90065	Plant -----	Kern.
Southwestern Portland Co. ³	1034 Wilshire Blvd. Los Angeles, Calif. 90017	----do -----	San Bernardino.
Clays:			
Gladding, McBean Co ----	Box 578 Corona, Calif. 91720	Pits -----	Amador, Inyo, Riverside, Sutter, Yuba.
Interpace Corp -----	2901 Los Feliz Blvd. Los Angeles, Calif. 90039	----do -----	Amador, Placer, Riverside, Sutter, Yuba.
Lightweight Processing Co.	650 South Grand Ave. Los Angeles, Calif. 90017	Pit -----	Ventura.
Pacific Clay Products Co	1255 West 4th St. Los Angeles, Calif. 90017	Pits -----	Amador, Orange, Riverside.
Copper:			
Stauffer Chemical Co ----	636 California St. San Francisco, Calif. 94108	Lode mine -----	Shasta.
Union Carbide Corp. ⁶ ----	270 Park Ave. New York, N.Y. 10017	Underground mine.	Inyo.
Diatomite:			
Grefco, Inc -----	630 Shatto Pl. Los Angeles, Calif. 90005	Open pit mine ----	Santa Barbara.
Johns-Manville Products Corp. ⁷	Lompoc, Calif. 93436 -----	----do -----	Do.
Feldspar:			
Calspar Corp -----	12402 Los Nietos Rd. Santa Fe Springs, Calif. 90670	----do -----	San Bernardino.
Owens-Illinois, Inc -----	Box 1035 Toledo, Ohio 43601	----do -----	Monterey.
Gold:			
Dickey Exploration Co ----	Box K Alleghany, Calif. 95910	Lode mine -----	Sierra.
Yuba Goldfields, Inc -----	Hammonton-Smartsville Rd. (Hammonton) Marysville, Calif. 95901	Placer mine -----	Yuba.
Gypsum:			
Fannin-Superior Gypsum Co.	Rt. 1, Box 7, Hwy. 46 Wasco, Calif. 93280	Open pit mine ----	Kern.
H. M. Holloway, Inc -----	714 6th St. Wasco, Calif. 93280	----do -----	Do.
United States Gypsum Co	101 S. Wacker Dr. Chicago, Ill. 60606	Open pit mine and plant.	Imperial.
Iron ore:			
Kaiser Steel Corp -----	Box 153 Eagle Mountain, Calif. 92241	----do -----	Riverside.

See footnotes at end of table.

Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime:			
Amstar Corp -----	50 California St. San Francisco, Calif. 94106	Plants -----	Monterey and Yolo.
Holly Sugar Corp -----	Box 1052 Colorado Springs, Colo. 80901	-----do-----	Glenn, Imperial, Orange, San Joaquin.
Magnesium compounds:			
Kaiser Aluminum & Chemical Corp. -----	Moss Landing, Calif. 95039	Plant -----	Monterey.
Merck & Co., Inc -----	Rahway, N.J. 07065	-----do-----	San Mateo.
Natural gas liquids:			
Atlantic Richfield Co. ⁸ -----	445 South Figueroa St. Los Angeles, Calif. 90054	Plants -----	Kern, Santa Barbara, Ventura.
Union Oil Co. of California. ⁹ -----	Box 7600 Los Angeles, Calif. 90054	-----do-----	Various.
Peat:			
Delta Humus Co -----	Box 89 Holt, Calif. 95234	Bog -----	San Joaquin.
Radel, Inc -----	Box 7075 Reno, Nev. 89502	Bog -----	Modoc.
Perlite (crude):			
American Perlite Co -----	11831 Vose St. North Hollywood, Calif. 91605	Open pit mine ---	Inyo.
Perlite (expanded):			
Harborlite Corp -----	Box 458 Escondido, Calif. 92025	Plant -----	San Diego.
Paramount Perlite Co., Inc. -----	Box 83 Paramount, Calif. 90723	-----do-----	Los Angeles.
Redco, Inc. -----	11831 Vose St. North Hollywood, Calif. 91605	-----do-----	Do.
Petroleum and natural gas⁹			
Phosphate rock: California Phosphate Co. -----	3838 Carson St., Suite 220 Torrance, Calif. 90503	Open pit mine ---	Santa Barbara.
Pumice:			
Cinder Products Co -----	3450 Lakeshore Ave. Oakland, Calif. 94610	-----do-----	Lake.
Featherrock, Inc -----	2890 Empire St., Box 6190 Burbank, Calif. 91510	Pit -----	Mono.
Hitchcock Bros. Cinders, Inc. -----	Point Lakeview Rd. Lower Lake, Calif. 95457	Pit -----	Lake.
Red Lava Products of California. -----	Star Route Clearlake, Calif. 95423	Plant -----	Do.
U.S. Pumice Co -----	Box 6190 Burbank, Calif. 91510	-----do-----	Mono.
Rare-earth minerals:			
Molycorp, Inc -----	Nipton, Calif. 92366	-----do-----	San Bernardino.
Salt:			
Leslie Salt Co. ¹⁰ -----	505 Beach St. San Francisco, Calif. 94111	Open pit mines and evaporators.	Alameda, Napa, San Bernardino, San Mateo.
Sand and gravel:			
Conrock Co -----	Box 2950, Terminal Annex Los Angeles, Calif. 90051	Pits -----	Los Angeles, Orange, San Bernardino.
Kaiser Industries Corp. ⁴ -----	300 Lakeside Dr. Oakland, Calif. 94612	-----do-----	Alameda, Contra Costa, Glenn, Santa Clara.
Owl Rock Products Co -----	Box 47 Irwindale, Calif. 91707	-----do-----	Fresno, Los Angeles, Orange, Riverside.
Pacific Cement & Aggregates. ⁴ -----	400 Alabama St. San Francisco, Calif. 94110	-----do-----	Alameda, Fresno, Monterey, Sacramento, San Joaquin, San Mateo, Santa Cruz, Tulare, Yolo.

See footnotes at end of table.

Table 14.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Silver:			
Claude B. Lovestedt ¹¹	Box 1496 Carson City, Nev. 89701	Mine	Alpine.
Montecito Mining Co	Box 5445 Santa Barbara, Calif. 93108	Lode mine	Inyo.
Stone:			
Basalt Rock Co., Inc	Box 2540 Napa, Calif. 94558	Quarry	Marin, Napa, Sonoma.
East Bay Excavating Co	28814 Mission Blvd. Hayward, Calif. 94544	do	Kern and San Bernardino.
Granite Rock Co	Box 151 Watsonville, Calif. 95076	do	San Benito.
Tungsten:			
Union Carbide Corp. ¹²	270 Park Ave. New York, N.Y. 10017	Underground mine.	Inyo.

¹ Also sodium compounds.² Byproduct of natural gasoline processing; also petroleum production.³ Also clays and stone.⁴ Also stone.⁵ Also clays, sand and gravel, stone.⁶ Also crude asbestos, gold, silver, molybdenum, tungsten.⁷ Also talc, soapstone, pyrophyllite.⁸ Also petroleum and natural gas.⁹ Most of the major oil and gas companies and many smaller companies operate in California; several commercial directories contain lists of them.¹⁰ Also calcium compounds.¹¹ Also gold, copper, lead, zinc.¹² See also listing under copper and footnote 6.

The Mineral Industry of Colorado

By Joseph Blake Smith¹

The value of mineral production in Colorado in 1976 was \$1.1 billion, 16% greater than in 1975. Most of this increase was caused by higher prices for energy resources, principally coal, natural gas, natural gas liquids, petroleum, and uranium. Mineral fuels represented more than one-half of the value of Colorado's mineral production. Petroleum alone accounted for more than one-third of the total value of all mineral output. Increases in the unit price of uranium and molybdenum offset declines in unit prices and lower production of other metals. Quantities of copper, gold, and lead produced were less than quantities produced in 1975.

Colorado ranked first in the Nation in output of molybdenum and tin, second in the output of tungsten and vanadium, and third in production of lead and silver.

Twenty-nine mineral commodities were produced in 1976. Of these, 12 were classified as nonmetals, 11 as metals, and 6 as fuels. Metals accounted for 30% of the total mineral value; fuels, 59%; and nonmetals, 11%. Based on value, the leading commodities in these groups were molybdenum, petroleum, and cement, respectively.

Five of the fuels and eight of the metals had gains in value in 1976. Six of the nonmetals had increases in value, and five had losses. Nineteen of the 29 commodities produced had outputs valued at over \$1 million; 14 had values exceeding \$10 million.

Legislation and Government Programs.—Early in 1976, Governor Richard Lamm announced a \$388,000 project to set up training programs for coal miners. The programs were established at three State vocational-technical schools: The Delta-Montrose Area Vocational School, Trinidad State Junior College, and Colorado North-

western Community College in Rangely. The Four Corners Regional Commission gave the State a \$107,623 grant for the first year of the program. The grant was supplemented by \$280,173 in State, local, and industry funds.

In an effort to eliminate duplicated efforts and several thousand dollars in dues, Governors of Western States decided to consolidate the functions and staffs of the Western Interstate Nuclear Board, the Western Governors Conference, and the Western Governors Regional Energy Policy Office (WGREPO) and to dissolve the Federation of Rocky Mountain States. The new regional organization, the Western Governors Policy Office, headquartered in Denver, will encompass energy, water, agriculture, and other areas of multistate interest. WGREPO was established in Denver in 1975 by the Governors of Colorado, Arizona, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Utah, and Wyoming to coordinate regional energy policy.

In September, President Ford signed a bill that included \$2.75 million for rehabilitation of the Leadville Mine Drainage Tunnel in the Leadville mining district, Lake County. The 12,000-foot tunnel, built by the Bureau of Mines between 1943 and 1952 to provide drainage for mines, had been unused for years and since 1959, when the Bureau of Reclamation took over maintenance, had had only emergency repairs. Cave-ins and a buildup of an estimated 8 million gallons of water near the blocked portal of the tunnel prompted the legislative action. The bill calls for rehabilitating

¹ State Liaison Officer, Bureau of Mines, Denver, Colo.

Table 1.—Mineral production in Colorado ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide -----thousand cubic feet..	229,382	W	317,720	W
Clays -----thousand short tons..	480	\$1,101	² 479	² \$1,976
Coal (bituminous) -----do.....	8,219	135,872	9,437	144,364
Copper (recoverable content of ores, etc.) short tons..	3,560	4,571	2,431	3,384
Gem stones -----	NA	145	NA	142
Gold (recoverable content of ores, etc.) troy ounces..	55,483	8,960	50,764	6,362
Gypsum -----thousand short tons..	185	782	215	984
Lead (recoverable content of ores, etc.) short tons..	27,088	11,648	26,749	12,358
Lime -----thousand short tons..	198	4,577	185	4,406
Natural gas -----million cubic feet..	171,629	44,624	183,972	88,307
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels..	1,742	9,378	1,904	13,403
LP gases -----do.....	4,821	22,803	6,505	38,249
Peat -----thousand short tons..	37	280	33	238
Petroleum (crude) -----thousand 42-gallon barrels..	38,089	365,654	38,992	376,273
Sand and gravel -----thousand short tons..	20,019	34,850	³ 20,160	³ 32,900
Silver (recoverable content of ores, etc.) thousand troy ounces..	3,366	14,878	4,083	17,762
Stone -----thousand short tons..	5,315	10,940	5,299	12,555
Zinc (recoverable content of ores, etc.) short tons..	48,460	37,799	50,621	37,460
Value of items that cannot be disclosed:				
Cement, clays (bentonite, 1976), feldspar, iron ore, molybdenum, perlite, pumice, pyrites, salt, sand and gravel (industrial, 1976), tin, tungsten concentrate, uranium, vanadium, and values indicated by symbol W	XX	^r 249,211	XX	319,043
Total	XX	^r 958,073	XX	1,110,166
Total 1967 constant dollars	XX	380,189	XX	^p 399,105

^p Preliminary. ^r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes bentonite; value included with "Value of items that cannot be disclosed."

³ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Colorado, by county ¹
(Thousands)

County	1975	1976 ²	Minerals produced in 1976 in order of value
Adams -----	\$49,319	\$58,134	Petroleum, natural gas liquids, natural gas, sand and gravel, lime, stone.
Alamosa -----	45	W	Sand and gravel, peat.
Arapahoe -----	22,256	22,113	Petroleum, sand and gravel, natural gas liquids, natural gas, stone.
Archuleta -----	498	486	Petroleum, sand and gravel, natural gas.
Baca -----	1,459	2,981	Natural gas, petroleum, sand and gravel.
Bent -----	309	880	Do.
Boulder -----	17,707	21,601	Cement, sand and gravel, stone, lime, clays, petroleum, tungsten, peat, gold.
Chaffee -----	W	W	Stone, sand and gravel, peat.
Cheyenne -----	W	6,876	Petroleum, natural gas liquids, natural gas, sand and gravel.
Clear Creek -----	621	W	Molybdenum, sand and gravel, gold, lead, silver, copper.
Conejos -----	W	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Colorado, by county ¹—Continued
(Thousands)

County	1975	1976 ²	Minerals produced in 1976 in order of value
Costilla -----	W	W	Pumice.
Crowley -----	\$51	\$19	Sand and gravel.
Custer -----	W	W	Perlite, sand and gravel.
Delta -----	W	W	Sand and gravel, lime, (coal).
Denver -----	80	W	Clays, sand and gravel, stone.
Dolores -----	3,015	2,553	Petroleum, natural gas, silver, stone, gold, zinc, lead, copper.
Douglas -----	W	608	Clays, sand and gravel, stone.
Eagle -----	12,394	W	Zinc, lead, sand and gravel, silver, copper, gold, pumice, stone.
Elbert -----	1,011	1,359	Petroleum, natural gas, sand and gravel, clays, stone.
El Paso -----	W	W	Sand and gravel, stone, clays.
Fremont -----	30,331	39,715	Cement, stone, gypsum, petroleum, sand and gravel, clays, feldspar, (coal).
Garfield -----	2,654	2,221	Natural gas, sand and gravel, stone, vanadium, uranium.
Gilpin -----	157	W	Gold, copper, lead, silver, peat.
Grand -----	685	441	Sand and gravel, stone.
Gunnison -----	W	100	Stone, sand and gravel, (coal).
Hinsdale -----	8	W	Gold, sand and gravel, silver, copper, zinc.
Huerfano -----	W	119	Sand and gravel, petroleum, natural gas, stone.
Jackson -----	9,659	5,734	Petroleum, natural gas, sand and gravel, (coal).
Jefferson -----	W	W	Sand and gravel, uranium, stone, clays.
Kiowa -----	W	5,235	Petroleum, natural gas, sand and gravel.
Kit Carson -----	W	W	Sand and gravel, petroleum, stone.
Lake -----	180,467	214,538	Molybdenum, tungsten, zinc, silver, lead, gold, tin, copper, sand and gravel, pyrites.
La Plata -----	14,071	21,335	Natural gas, natural gas liquids, sand and gravel, petroleum, gold, silver, copper, lead, zinc, (coal).
Larimer -----	16,270	18,251	Cement, stone, petroleum, sand and gravel, gypsum, lime, natural gas.
Las Animas -----	19,029	W	Sand and gravel, clays, stone, (coal).
Lincoln -----	348	W	Sand and gravel, petroleum, stone.
Logan -----	12,077	11,726	Petroleum, natural gas, natural gas liquids, sand and gravel, lime.
Mesa -----	5,435	7,333	Uranium, sand and gravel, vanadium, natural gas liquids, natural gas, petroleum, stone, (coal).
Mineral -----	12,093	W	Silver, lead, zinc, copper, gold, stone.
Moffat -----	22,311	17,226	Natural gas, petroleum, sand and gravel, uranium, vanadium, stone, (coal).
Montezuma -----	2,798	2,761	Petroleum, sand and gravel, natural gas, carbon dioxide, stone.
Montrose -----	9,214	W	Uranium, vanadium, sand and gravel, salt, stone, (coal).
Morgan -----	7,292	7,301	Petroleum, natural gas liquids, natural gas, lime, sand and gravel.
Otero -----	W	603	Lime, sand and gravel.
Ouray -----	W	6,576	Zinc, lead, silver, copper, gold, sand and gravel.
Park -----	W	W	Peat, sand and gravel, stone.
Phillips -----	42	64	Sand and gravel.
Pitkin -----	19,663	4,067	Iron ore, natural gas, sand and gravel, (coal).
Prowers -----	451	982	Natural gas, petroleum, sand and gravel, stone.
Pueblo -----	W	W	Lime, sand and gravel, clays.
Rio Blanco -----	216,433	227,506	Petroleum, natural gas, natural gas liquids, sand and gravel, uranium, vanadium, stone.
Rio Grande -----	W	W	Sand and gravel.
Routt -----	W	1,885	Petroleum, sand and gravel, natural gas, (coal).
Saguache -----	W	W	Uranium.
San Juan -----	W	W	Zinc, gold, lead, silver, copper, stone.
San Miguel -----	35,491	33,324	Vanadium, uranium, zinc, lead, copper, silver, gold, natural gas, sand and gravel, petroleum.
Sedgwick -----	W	W	Lime, natural gas, sand and gravel.
Summit -----	W	714	Sand and gravel.
Teller -----	W	W	Gold, peat, silver, stone, sand and gravel.
Washington -----	22,404	22,363	Petroleum, natural gas, sand and gravel, stone.
Weld -----	65,942	102,811	Petroleum, natural gas, natural gas liquids, sand and gravel, lime, stone, (coal).
Yuma -----	W	W	Natural gas, sand and gravel.
Undistributed ³ -----	r 143,979	237,573	
Total ⁴ -----	r 958,073	1,110,166	

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Values for petroleum are based on an average price per barrel for the State.

³ County data exclude value of bituminous coal, which is not available on a county basis; value included with "Undistributed." Counties having coal production in 1976 have the word (coal) inserted as a final entry in the column "Minerals produced in 1976 in order of value"; this placement, however, should not be taken to indicate the relative ranking of coal produced in the county.

⁴ Includes gem stones, coal (1976), and values indicated by symbol W.

⁵ Data may not add to totals shown because of independent rounding.

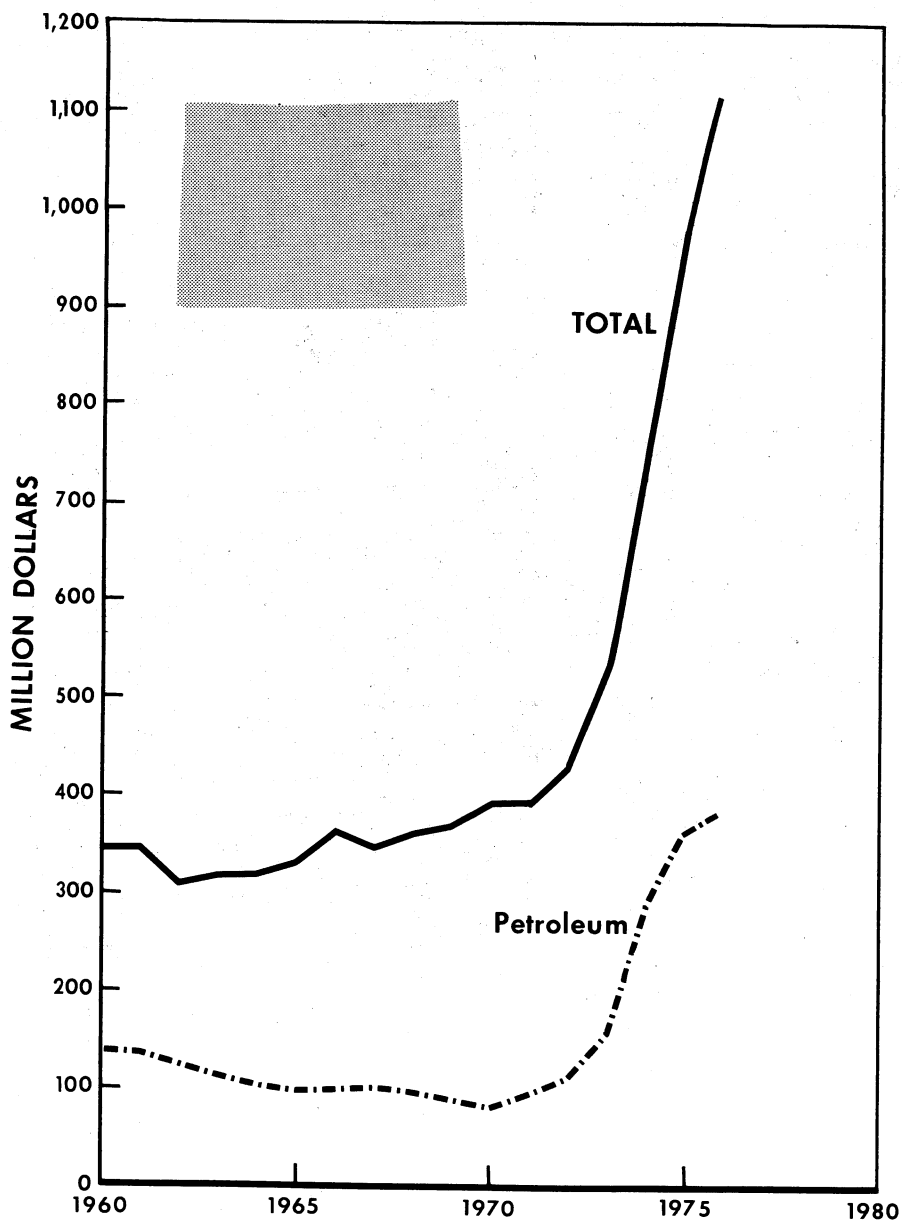


Figure 1.—Value of petroleum and total value of mineral production in Colorado.

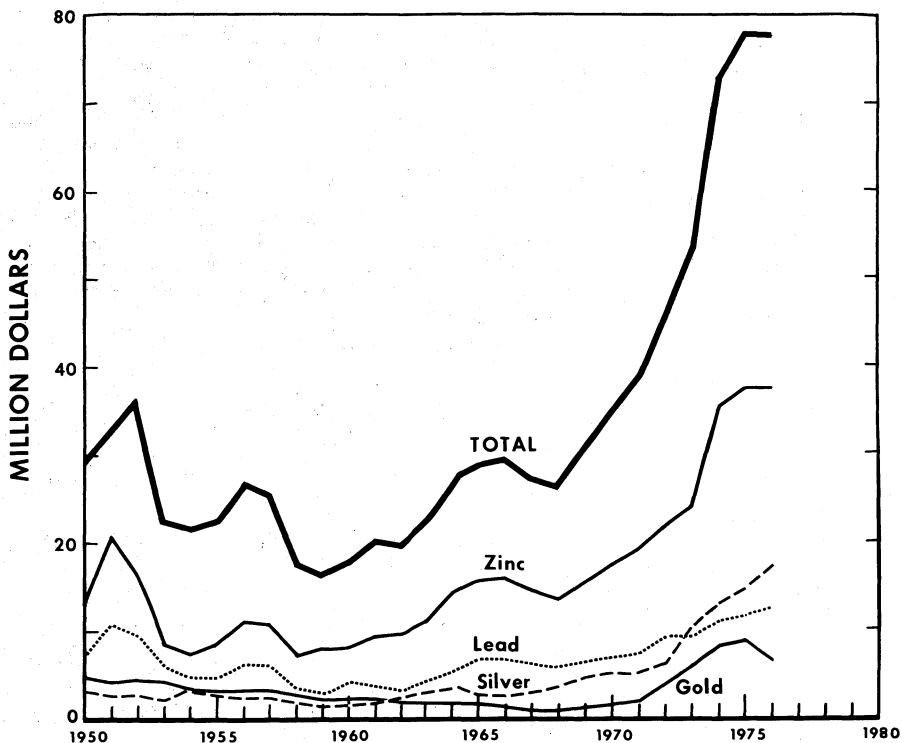


Figure 2.—Value of mine production of gold, lead, silver, and zinc, and total value of these minerals (including copper) in Colorado.

the first 1,000 feet of the tunnel with concrete and steel, for monitoring the water flow, and for studying ways to treat polluted water discharged from the tunnel.

As part of a major experiment to examine environmental problems of oil shale mining, the Federal Bureau of Mines contracted for a shaft to be drilled on Horse Draw in the Piceance Creek basin, Rio Blanco County.

On July 1, Colorado's Mined Land Reclamation Act (HB 1065) became effective. Signed into law in May by Governor Lamm, the act repealed all previous reclamation laws and combined into one law a system of regulating prospecting and mining of minerals throughout the State. The act includes oil shale but does not include surface or subsurface water, geothermal resources, and oil and gas and other chemicals recovered therewith. A board to implement the act was created, and the Department of Natural Resources was delegated the authority to administer the requirements of the act through a new agency called the Division of Mined Land

Reclamation. The act requires operators to file for permits before mining begins. Permit applications require a fee not to exceed \$2,000, a reclamation plan, a site map, information on surface and subsurface ownership, a description of mining method, and a timetable for the operation.

Applications for mining permits are reviewed by the board for approval, denial, or the holding of a public hearing. The basis for application denial is limited to seven specific reasons. The act imposes 18 duties onto operators. A simplified permit procedure applies to operations affecting less than 10 acres where less than 70,000 tons of mineral and overburden are extracted per calendar year.

For the second consecutive year, the Senate and House of Representatives of the State Legislature deadlocked over proposed severance taxes on minerals produced in the State. Proponents of severance taxes then tried the initiative route to amend the State's constitution. The amendment, voted on in the November general election, failed to pass.

Table 3.—Indicators of Colorado business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands---	1,143.4	1,217.0	+6.4
Unemployment -----do-----	72.1	71.0	-1.5
Employment (nonagricultural):			
Mining -----do-----	19.7	21.2	+7.6
Manufacturing -----do-----	135.9	141.1	+3.8
Contract construction -----do-----	50.7	49.6	-2.2
Transportation and public utilities -----do-----	59.8	60.3	+0.8
Wholesale and retail trade -----do-----	230.4	236.2	+2.5
Finance, insurance, real estate -----do-----	56.3	59.0	+4.8
Services -----do-----	183.6	193.0	+5.1
Government -----do-----	210.2	214.2	+1.9
Total nonagricultural employment -----do-----	946.6	974.7	+3.0
Personal income:			
Total -----millions---	\$15,086	\$16,633	+10.3
Per capita -----do-----	\$5,936	\$6,440	+8.5
Construction activity:			
Number of private and public residential units authorized -----do-----	16,793	24,951	+48.6
Value of nonresidential construction -----millions---	\$275.6	\$300.8	+9.1
Value of State road contract awards -----do-----	\$69.0	\$135.0	+95.7
Shipments of portland and masonry cement to and within the State -----thousand short tons---	1,186	1,227	+3.5
Mineral production value:			
Total crude mineral value -----millions---	\$958.1	\$1,110.2	+15.9
Value per capita, resident population -----do-----	\$377	\$430	+14.1
Value per square mile -----do-----	\$9,190	\$10,649	+15.9

^p Preliminary. ^r Revised.

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.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Dioxide.—According to the Colorado Oil and Gas Conservation Commission,² sales of carbon dioxide from the McElmo field, Montezuma County, were 317 million cubic feet, a 38.5% increase above 1975 sales. Production totaled 4,093 million cubic feet, a 2.7% decline from 1975 output. Some of the carbon dioxide production is used for oil reservoir repressuring. Tertiary oil recovery using carbon dioxide could double the amount of oil recovered using primary and secondary recovery methods.³

Coal (Bituminous).—Coal production increased 15% (1,218,000 tons) in 1976 over that of 1975; value increased only 6%. Thirty-six producing mines operated in 12 counties, 3 mines more than in 1975. Strip mine production again exceeded that of underground mines. Fifteen strip mines produced 65% of the State output. Twenty-one underground mines, three more than last year, produced 3,283,000 tons of coal, a 5% decrease from underground production in 1975. Routt County, with seven mines, again had the highest production—more

than 5.5 million tons, 59% of the State output. Four other counties had outputs of more than 500,000 tons each. In order of rank, they were Gunnison, Pitkin, Las Animas, and Moffat.

Average price of coal mined in 1976 was \$15.30 per ton. Coal from underground mines averaged \$27.90 per ton, while that from strip mines averaged \$8.91 per ton; comparable figures for 1975 were \$16.53, \$27.16, and \$8.86, respectively.

Colorado's coal mining industry provided direct employment to 2,259 workers; of these 1,382 worked at underground mines, 547 at strip mines, and the remainder at miscellaneous surface jobs.⁴ The average number of days worked in 1976 by an employee was 149 compared with 161 in 1975.

² Colorado Department of Natural Resources, Colorado Oil and Gas Conservation Commission. Oil and Gas Statistics, 1976.

³ Four Corners Advisor. V. 1, No. 20, January 1977.

⁴ Division of Mines. Coal 1975. Colorado Department of Natural Resources. Colorado Coal Statistics. P. 16. All coal employment and data other than production and price data cited in the preceding text of this chapter are from this publication.

Table 4.—Colorado: Bituminous coal production in Colorado in 1976, by type of mine and county

County	Number of mines			Production (thousand short tons)			Value (thousands)
	Under-ground	Sur-face	Total	Under-ground	Sur-face	Total	
Delta	2	--	2	188	--	188	W
Fremont	1	3	4	41	50	91	W
Gunnison	6	--	6	1,057	--	1,057	W
Jackson	--	2	2	--	270	270	W
La Plata	1	--	1	17	--	17	W
Las Animas	1	2	3	619	31	1 649	W
Mesa	1	--	1	43	--	43	W
Moffat	1	1	2	349	166	515	W
Montrose	--	1	1	--	98	98	W
Pitkin	5	--	5	889	--	889	W
Routt	1	6	7	14	5,539	5,553	W
Weld	2	--	2	67	--	67	W
Total	21	15	36	1 3,283	6,154	9,437	\$144,364

W Withheld to avoid disclosing company proprietary data; included in "Total."
¹ Data may not add to totals shown because of independent rounding.

Underground coal was mined principally by continuous-mining machines, and more than 99% of the coal was loaded by machine.

Colorado's coal was transported to market by either rail or truck. Seventy-one percent of the coal was consumed in the State; the remainder was shipped to out-of-State markets. Most of the coal was consumed as mine-run coal. About 1,500 tons was consumed at the mines. Ten percent of the State's coal output was processed in washing plants, and 2% was chemically treated or oiled.

Nearly all captive production was used in making steel in Colorado and Utah. The principal purchaser and/or consumer of merchant coal was the electric utility industry; most of the steam-operated plants in the State use coal for electric power generation.

The five largest mines, in order of output, were Energy strip mine No. 1 of Energy Fuels Corp.; Seneca strip mine No. 2 of Seneca Coals, Ltd.; Edna strip mine of the Pittsburg & Midway Coal Mining Co.; Energy strip mine No. 2 of Energy Fuels Corp.; and the Somerset underground mine of United States Steel Corp. Coal from the Somerset underground mine was consumed for steel manufacture, while that from the four strip mines was utilized almost entirely for electric power generation.

Natural Gas.—Marketed production of natural gas increased only 7.2% in quantity but increased 97.9% in total value. Marketed production of natural gas during the year was 184.0 billion cubic feet, with a value of \$88.3 million. Average value per 1,000 cubic feet increased from \$0.26 in 1975 to \$0.48 for 1976.

Twenty-eight counties reported production of natural gas. Of these, the three leading counties were Weld with 58.2 billion cubic feet, Rio Blanco with 26.6 billion cubic feet, and La Plata with 25.8 billion cubic feet.

The principal source of dry gas was the Wattenburg field in Weld and Adams Counties with production of 38.7 billion cubic feet. The productive horizons were the J and D sands (Cretaceous). The second most productive field was the Ignacio-Blanco field in La Plata County with production of 23.9 billion cubic feet. The productive horizons are the Dakota, Fruit-

land-Pictured Cliffs, and Mesaverde Formations (Cretaceous).⁵

The American Gas Association (AGA) and the American Petroleum Institute (API), in their annual reserve estimates, gave Colorado natural gas reserves at 1.89 trillion cubic feet as of December 31, 1976. New fields, revisions, and extensions added 170 billion cubic feet; this was slightly below production, resulting in a decrease in total reserves.⁶

The State's seven gas storage projects, Asbury Creek, Fort Morgan, Fruita, House Creek, Latigo, Leyden Mine, and Springdale, had 23.5 billion cubic feet of gas in storage at the beginning of 1976; 17.0 billion was injected and 12.8 billion was withdrawn during the year for a yearend balance of 27.7 billion cubic feet. The Fort Morgan reservoir, Morgan County, was the most active, with 8.1 billion cubic feet injected and 9.7 billion cubic feet withdrawn. The second most active was the Leyden Mine reservoir in Jefferson County, a converted coal mine, with 2.6 billion cubic feet injected and 2.6 billion cubic feet withdrawn.

Natural Gas Liquids.—Production of natural gas liquids rose 28% in quantity and 60% in value compared with that reported in 1975. The weighted average value for natural gasoline increased 31%, and that for LP gases rose 24% over the 1975 value. Natural gas throughput at 34 gasoline plants in Colorado was 175.6 billion cubic feet for the year; output was 8.4 million barrels of product.⁷

Oil Shale.⁸—1976 was one of change with economic, environmental, and political uncertainties perplexing the industry. Although there was no commercial production from any of the oil shale projects, there was considerable development and testing activity, and study of the project areas. Tracts C-a and C-b will be summarized together because both are Federal leases under operating control of private companies and have many of the same activities.

⁵ Work cited in footnote 2.

⁶ American Gas Association, Inc., American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada as of December 31, 1976. V. 30, May 1977, p. 113.

⁷ Work cited in footnote 2.

⁸ Glenwood Springs Rocky Mountain Observer. Jan. 5, 1977.

Table 5.—Colorado: Gas input and production at natural gas liquids extraction plants in 1976

Plant	County	Owner	Gas input (million cubic feet)	Production (thousand barrels)
Adena	Morgan	Union Oil Co. of California	1,431	154
Barrel Springs	Prowers	Lamar Utilities Board	783	1
Bennett	Adams	Halliburton Resources Management	114	7
Big Hole	Moffat	Gasco Inc	1,709	11
Brighton	Adams	Halliburton Resources Management	2,009	134
Buck Peak	Moffat	Trend Exploration Ltd	313	15
Bugle	Adams	Vessels Gas Processing Co	192	25
Cabin Creek	do	Ecological Engineering Systems Inc	151	23
Denver Central	Arapahoe	Sun Production Co	2,843	311
Dragon Trail	Rio Blanco	do	4,420	184
Fruita	Mesa	Continental Oil Co	6,956	166
Irondale	Adams	Halliburton Resources Management	2,075	176
Irondale Cryogenics	do	Vessels Gas Processing Co	--	46
Loveland	Larimer	Loveland Gas Processing	106	10
McClave	Kiowa	Planet Engineers, Inc	1,576	70
Peoria	Arapahoe	Amoco Production Co	2,591	475
Piceance Creek	Rio Blanco	Chadbourne Corp	8,539	111
Rangely	do	Chevron USA, Inc	1,963	263
Roggen	Weld	Crystal Oil Co	4,084	287
San Juan	La Plata	Northwest Pipeline Corp	69,493	1,584
Space City	Weld	Vessels Gas Processing Co	511	32
Spindle	do	Amoco Production Co	10,724	1,584
Do	do	Ione Pas Co	672	41
Do	do	TOA-American Gas Products Co	2,875	184
Do	do	Ecological Engineering Systems Inc	41	2
South Canyon	Garfield	Western Slope Gas Co	1,279	2
Tampa	Weld	Phillips Petroleum Co	2,373	300
Third Creek	Adams	Amoco Production Co	1,540	86
Do	do	Koch Oil Co	6,485	625
Vallery	Morgan	Vallery Corp	806	53
Wattenberg	Weld	Amoco Production Co	42,375	3,628
West Douglas Creek	Rio Blanco	Western Slope Gas Co	396	12
Wilson Creek	do	Texaco, Inc	796	57
Yenter	Logan	Excelsior Oil Corp	1,218	102
Total			183,939	10,761

Sources: Colorado Oil and Gas Conservation Commission, Department of Natural Resources. 1976 Oil and Gas Statistics.

Tract C-a, known as the Rio Blanco Oil Shale Project, is leased by Gulf Oil Corp. and Standard Oil Co. of Indiana. In March the companies submitted a Detailed Development Plan (DDP) as well as social and economic impact statements and a master plan for community development. A suspension on development regulations and lease payments was requested from the Area Oil Shale Supervisor's Office. In September, a 1-year suspension was granted. The major reasons for the request were (1) the Federal Clean Air Act was not completely understandable, (2) more land was needed for dumping spent shale, and (3) town facilities needed expansion and improvement, as did roads in the area and to the mine site. The State was to help financially, but by yearend had not passed the required legislation. The companies were still working on the development phase of the project during the suspension by conducting environmental monitoring, obtaining various government permits, licenses, etc., and community planning.

At tract C-b there was a change in lessees. In December 1975, Tosco Corp. and Atlantic Richfield Co. withdrew from the joint venture with Ashland Oil Co. and Shell Oil Co. Tosco and Atlantic Richfield were still active in the Colony Development Operation. The reasons given for the withdrawal were the lack of a Federal incentives program and various other financial developments.⁹ Ashland and Shell submitted a DDP in February and later requested a suspension, the same as for tract C-a, because of technical problems with rock mechanics and extraction ratios. The suspension was granted in September for 1 year. Shell withdrew from the tract in November and also from the Colony operation but still retained interests in other oil shale lands. Ashland was then joined by Occidental Oil Shale, Inc., as an equal partner. During the suspension, the companies will continue environmental studies and develop surface and in situ methods for extracting the oil.

Private oil shale ventures on private lands were also active during 1976. The Colony Development operation is still in suspension while the environmental impact statement is being finished. Work on the operation consisted of caretaker jobs, environmental monitoring, and collection of mine and rock mechanics data.

The Paraho Oil Shale Project at Anvil Points began to phase down for lack of funds during early 1976, but in the fall, a Navy contract for 100,000 barrels was received. The oil would be used in testing synthetic military products.

Occidental Oil Shale, Inc., continued field tests of its modified in situ technology on private land near DeBeque, as well as expanding into tract C-b with Ashland Oil Co. In January, Occidental ignited its first large-scale underground retort. It produced 300 barrels of oil per day in March and 575 barrels per day in April.¹⁰

Superior Oil Co. continued its efforts to trade 1,769 acres for 2,571 acres of Bureau of Land Management land and to develop an integrated process to extract oil, nahcolite (soda ash), and dawsonite (alumina) from the oil shale rock.

A joint venture of several independent geologists, Cleveland Cliffs Iron Co., and Northwestern Mutual Life Insurance Co. is planning to start a mine in 1977 to recover the nahcolite and dawsonite as main products and the oil as a byproduct. The mine area is 20 miles southwest of Meeker and contains 5,000 acres. The venture will be called Yankee Gulch.

To further study of the environmental effects of oil shale mining in the Piceance Creek basin, the Federal Bureau of Mines contracted with Rowan Drilling Co. of Houston, Tex., to drill an 8-foot-diameter shaft, 2,350 feet deep; drilling was to be started in February 1977. Ultimately the shaft will be used as a ventilation shaft for an experimental mine which has been proposed by the Bureau of Mines.^{11 12}

Peat.—Output of peat was down 11% in quantity and 15% in value from that of 1975. Nine producers mined 33,000 tons of peat in six counties. Park County had the most production, followed by Teller County. Three producers operated in Teller County, two in Park, and one each in Boulder, Chaffee, Alamosa, and Gilpin Counties. All but one of the operations produced moss-type peat. One operator in Chaffee County produced reed sedge peat. Average value of peat sold in 1976 was \$7.18, down 39 cents from that of 1975.

⁹ Colorado Springs Gazette—Telegraph. Dec. 20, 1975.

¹⁰ Rocky Mountain News (Denver). Apr. 30, 1976.

¹¹ Craig Daily Press. Aug. 6, 1976.

¹² Denver Post. Oct. 10, 1976.

Most of the output was shipped in bulk with a small amount packaged. The primary use of the peat was for general soil improvement.

Petroleum.—Production of crude petroleum was up 2.4% and total value was up 2.9% compared with the 1975 figure. The average wellhead value per barrel increased 5 cents to \$9.65. At yearend, 2,827 wells were producing oil.

Petroleum continued to be the most valuable mineral commodity produced in the State, accounting for 33.9% of the State's mineral output value.

The Rangely-Weber oil reservoir continued to be the leading oil producer in the State with output of 20.8 million barrels, 53.3% of the total. Because of the Rangely field, Rio Blanco County easily retained its position as the leading oil-producing county. The Spindle field, north of Denver in Adams and Weld Counties, with output of 5.0 million barrels, ranked second in the State in production.¹³

The 41 active fluid-injection projects in 35 fields consisted of 38 waterflood projects, 2 combined gas-water projects, and 1 gas injection project. Total injected water was 160.7 million barrels, of which 68.8%—110.5 million barrels—was injected in the Rangely-Weber reservoir. No distinctions made between "new" water and produced water reinjected in the reservoirs.¹⁴

Colorado's crude oil reserves as of December 31, 1976, were estimated by the American Petroleum Institute and the American Gas Association at 251.8 million barrels, a decline of 24.3 million barrels (8.8%) from the yearend 1975 estimate. An additional 43.3 million barrels was indicated in known reservoirs. New fields and new reservoir discoveries added 895,000 barrels; revisions and extensions added 12.6 million barrels.¹⁵

At yearend, the State's three oil refiners were Asamera Oil (U.S.) Ltd. and Continental Oil Co. in Denver and Gary Western Co. in Fruita. Combined capacity of the three was 64,200 barrels per calendar day.¹⁶ Asamera acquired its refinery from The Refinery Corp. in July for a reported \$9 million.¹⁷

Colorado refineries received 18.0 million barrels of crude oil during the year; 7.5 million were from intrastate sources, and 10.5 million were from out-of-State. Wyoming supplied most of the interstate crude

oil, 7.3 million barrels; next was Utah with 3.0 million barrels, followed by Montana with 83,000 barrels.

The State exported 27.2 million barrels of petroleum; 18.5 million (68.0%) went to Utah, 3.5 million went to Kansas, and the rest went to Illinois, Indiana, Minnesota, Wisconsin, Oklahoma, New Mexico, Texas, Wyoming, and California.

Exploration and Development.—For the first time since 1972, when 1,005 wells were completed, Colorado ranked first in drilling activity in the Rocky Mountain Region with 1,071 wells completed.¹⁸ However, this was 120 wells less than the number for 1975; footage drilled totaled 5.6 million. It was estimated that \$120 million was spent by the industry in the State for drilling and completion of wells.¹⁹ Again the Denver-Julesburg Basin was the area of most drilling activity; in fact, Weld County with 383 completions was the scene of greatest activity in the Rocky Mountains and was ranked fifth among counties in the Nation. The most active field was Spindle field with 235 wells successfully completed.

During the year, 331 exploratory wells were drilled²⁰ and resulted in 24 oil discoveries and 20 gas discoveries. From the standpoint of initial production, the most significant discovery was Amoco's No. 1 Champlin 287-Amoco A, in central Adams County, which flowed 458 barrels of oil per day from the D Sand (Cretaceous). The discovery was named the Strasburg field. A potentially significant discovery was the Phillips Petroleum Co.'s #1 Blekeberg, sec. 21, T 13 S. R. 49 W, Cheyenne County. The well, pumping 140 barrels of oil per day from the Spergen Formation (Mississippian), is about 30 miles from the nearest oil production.²¹

¹³ Pages 8-127 of work cited in footnote 2.

¹⁴ Pages 130-143 of work cited in footnote 2.

¹⁵ American Gas Association, American Petroleum Institute, and Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas, and Natural Gas Liquids in the United States and Canada as of December 31, 1976. V. 31, May 1977, pp. 112-113.

¹⁶ Oil and Gas Journal. Worldwide Directory, Refining and Gas Processing in July. 1977/78, p. 15.

¹⁷ Rocky Mountain News (Denver). July 15, 1976, p. 85.

¹⁸ Page 5 of work cited in footnote 2.

¹⁹ Petroleum Information, Inc. Resume of 1976 Oil and Gas Operations in the United States. V. 1, pp. 15, 32.

²⁰ Work cited in footnote 8.

²¹ Pages RM-23 to RM-28 of work cited in footnote 2.

Table 6.—Colorado: Oil production and gas sales in 1976, by county

County	Number of producing wells	Oil production (barrels)	Gas sales ¹ (thousand cubic feet)	Cumulative production to Jan. 1, 1977	
				Oil (barrels)	Gas (thousand cubic feet)
Adams	470	2,272,190	22,805,599	27,388,262	115,830,334
Arapahoe	124	1,458,535	3,824,226	16,108,525	37,149,743
Archuleta	36	45,211	26,529	5,976,643	304,293
Baca	87	39,256	5,276,640	1,584,677	59,645,378
Bent	15	18,312	1,434,743	109,056	4,426,269
Boulder	3	1,496	--	780,173	--
Cheyenne	52	507,768	--	3,880,649	117,501
Dolores	9	163,234	1,564,128	1,263,448	7,245,402
Ebert	13	99,302	740,945	567,730	3,086,986
Fremont	26	20,110	--	14,694,031	--
Garfield	48	--	2,460,708	564	29,605,767
Huerfano	1	424	--	1,558	1,882
Jackson	68	389,476	182,131	11,756,552	652,086,150
Jefferson	--	--	--	15,275	3,820
Kiowa	70	455,113	1,841,755	8,941,441	24,022,411
Kit Carson	2	6,462	--	36,028	--
La Plata	524	35,848	25,667,124	662,500	691,815,349
Larimer	59	208,241	70,455	13,896,662	22,418,989
Las Animas	--	--	--	--	2,390,121
Lincoln	--	221	--	221	--
Logan	265	1,029,694	1,383,490	98,622,228	189,387,851
Mesa	34	3,176	1,879,674	16,646	61,453,398
Moffat	198	731,512	18,923,457	53,044,126	460,828,226
Montezuma	43	199,087	610,097	6,452,617	19,567,353
Montrose	--	--	--	--	58,092
Morgan	126	444,040	1,775,641	83,382,617	176,597,201
Phillips	--	--	--	--	36,696
Pitkin	--	--	335,085	--	12,629,822
Prowers	14	16,570	1,399,120	63,321	2,074,417
Rio Blanco	632	21,925,268	23,142,729	634,169,435	1,043,548,515
Routt	20	154,320	13,415	4,393,979	538,239
San Miguel	7	9,010	1,301,169	96,428	18,646,299
Sedgwick	4	--	302,500	--	5,432,998
Washington	367	2,271,550	642,263	121,731,403	58,323,127
Weld	1,284	6,528,019	56,352,480	49,433,068	173,110,153
Yuma	16	--	387,799	13,109	682,635
Total	4,617	39,033,495	174,343,902	1,159,082,972	3,873,065,417

¹ Thousand cubic feet at 15.025 psi.

Sources: Colorado Department of Natural Resources, Oil and Gas Conservation Commission. Oil and Gas Statistics 1976. P. 7.

Table 7.—Colorado: Oil and gas well drilling completions in 1976, by county

County	Exploratory wells			Development wells			Total
	Oil	Gas	Dry	Oil	Gas	Dry	
Adams -----	4	--	24	37	8	19	92
Arapahoe -----	2	--	11	8	2	5	28
Archuleta -----	--	--	2	--	--	--	2
Baca -----	--	1	4	2	18	6	31
Bent -----	--	--	2	1	1	4	8
Boulder -----	--	1	1	--	--	1	3
Cheyenne -----	1	--	2	4	--	4	11
Crowley -----	--	--	2	--	--	--	2
Dolores -----	--	--	1	--	--	--	1
Eagle -----	--	--	1	--	--	--	1
Elbert -----	1	1	11	3	1	3	20
El Paso -----	--	--	1	--	--	--	1
Garfield -----	--	3	4	--	3	1	11
Grand -----	--	--	1	--	--	--	1
Huerfano -----	--	--	3	--	3	1	7
Jackson -----	--	--	--	2	1	--	3
Kiowa -----	1	--	5	--	2	6	14
La Plata -----	--	--	1	5	6	8	20
Larimer -----	--	--	4	11	1	1	17
Las Animas -----	--	--	1	--	--	--	1
Lincoln -----	1	1	3	--	--	--	5
Logan -----	3	2	32	6	1	14	58
Mesa -----	1	--	2	--	1	1	5
Moffat -----	--	1	12	--	1	3	17
Montezuma -----	--	1	4	2	1	2	10
Montrose -----	--	--	1	--	--	--	1
Morgan -----	2	--	20	5	3	4	34
Otero -----	--	--	3	--	--	--	3
Frowers -----	--	1	4	--	4	5	14
Pueblo -----	--	--	1	--	--	--	1
Rio Blanco -----	2	2	6	31	49	15	105
Routt -----	1	--	2	3	--	2	8
San Miguel -----	--	1	2	--	--	--	3
Sedgwick -----	--	--	--	--	--	1	1
Washington -----	1	--	78	18	1	31	129
Weld -----	4	1	25	287	53	13	383
Yuma -----	--	4	11	--	5	--	20
Total ----	24	20	287	425	165	150	1,071

Sources: Colorado Department of Natural Resources, Oil and Gas Conservation Commission. Oil and Gas Statistics 1976. P. 5.

METALS

Cadmium, Indium, and Thallium.—ASARCO Incorporated recovered cadmium, indium, and thallium metal and thallous sulfate at its Globe smelter in Denver from flue dust, dross, and byproduct materials from out-of-State smelters. The output was not included in the State mineral production because the origin of the processed materials could not be determined. Cadmium is contained in some zinc ores mined in Lake, Ouray, San Juan, and San Miguel Counties.

Copper.—Production of copper was 32% lower in 1976 than in 1975. Value for the year declined less (26%) than production because of an increase in the price of copper to 69.6 cents per pound for 1976 from 64.2 cents per pound for 1975. In spite of higher prices, most mines produced less copper than in 1975.

Lower production at Idarado Mining Co.'s Idarado mine in Ouray and San Miguel Counties and at Federal Resources Corp.'s Camp Bird mine in Ouray County accounted for 77% of the decline. Idarado, the largest copper producer in the State, produced 1.33 million pounds less in 1976 (3 million pounds) than in 1975 (4.33 million pounds) and accounted for 59% of the reduction in the copper output.

Of the other mines having copper production, Standard Metals Corp.'s Sunnyside mine on Cement Creek, north of Silverton, San Juan County, was the second largest producer of copper, followed by the Camp Bird mine. Other major producers, ranked in order of production, were Minerals Engineering Co.'s Emperius mine at Creede, Homestake Mining Co.'s Bulldog Mountain mine at Creede, ASARCO Incorporated's Leadville mine at Leadville, and The New Jersey Zinc Co.'s Eagle mine at Gilman. The Idarado, Sunnyside, and Camp Bird mines were responsible for 85% of the State's copper output.

Gold.—Output of gold decreased 4,719 troy ounces below the 1975 production of 55,483 troy ounces. Value for the year was down by 29% compared with that of 1975. Average price of gold for the year, \$125.32 per troy ounce, was \$36.17 per troy ounce below the average price of 1975 and accounted for most of the decline in gold value.

Twenty lode mines and two placer op-

erations in 13 counties yielded gold. Standard Metals Corp.'s Sunnyside mine, San Juan County, continued to be the State's largest gold producer and accounted for more than one-half of the total output.

Other principal gold sources, ranked in order of production, were ASARCO's Leadville mine, Idarado's Idarado mine with 7,763 troy ounces, and the Globe Hill operation of Gold Resources, Inc., at Cripple Creek in Teller County. Among the 13 counties with gold output during 1976, San Juan, Lake, San Miguel, Teller, and Ouray were the leaders; their production accounted for almost 96% of the State output.

Iron Ore.—The Cooper mine of Pitkin Iron Corp. near Ashcroft, Pitkin County, was operated by Morrison-Knudsen Co., Inc. In 1976, production and value were 129% and 145% respectively above that of 1975. The ore is shipped to the CF&I Steel Corp. smelter at Pueblo.

Lead.—Output of lead decreased 1%; however, because of a price increase, the value of production rose 6%. Average price for the year was 23.1 cents per pound.

The ASARCO Leadville mine was the largest source of lead, followed by Idarado's Idarado mine with 7,143 tons of lead. Other principal mines, in order of output, were the Sunnyside mine (Standard Metals), Bulldog Mountain mine (Homestake), Camp Bird mine (Federal Resources Corp.), Eagle mine (The New Jersey Zinc Co.), and Emperius mine (Minerals Engineering Co.).

Six of the 10 counties with lead production had output of more than 500 tons. Ranked according to output, the principal counties were Lake, San Miguel, San Juan, Mineral, Ouray, and Eagle.

Molybdenum.—Molybdenum was the most valuable metal and the second most valuable mineral commodity produced in Colorado. In 1976, production of molybdenum increased 4% and, because of price increases, value of production was up 24%. The Climax mine and the Henderson mine, both operated by Climax Molybdenum Co., a division of AMAX Inc., contributed over one-half of the Nation's output and a substantial part of the world's production of molybdenum.

At the Climax mine in Lake County, underground production reached 12,069,670 tons of ore, and production at the open pit

Table 8.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing ¹		Material sold or treated ² (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1974, total	25	1	1,321,489	52,083	\$8,319,740	2,783,978	\$13,112,536
1975, total	22	4	1,400,255	55,483	8,959,946	3,366,000	14,377,723
1976:							
Boulder	--	--	--	40	5,013	--	--
Clear Creek	3	--	536	76	9,524	1,311	5,703
Eagle	1	--	179,640	410	51,381	129,212	562,073
Gilpin	5	2	1,397	511	64,038	2,340	10,179
Ouray	1	--	136,013	1,433	179,583	165,025	717,858
San Miguel	1	--	309,591	7,763	972,860	376,985	1,639,885
Undistributed ³	10	--	667,407	40,531	5,079,346	3,408,298	14,826,097
Total	21	2	1,294,584	50,764	6,361,745	4,083,171	17,761,795
	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1974, total	3,012	\$4,656,796	24,609	\$11,074,214	49,489	\$35,533,340	\$72,696,626
1975, total	3,560	4,570,975	27,088	11,647,675	48,460	37,798,934	77,855,253
1976:							
Boulder	--	--	--	--	--	--	5,013
Clear Creek	1	1,542	16	7,207	--	--	23,976
Eagle	60	83,305	1,660	767,118	12,908	9,551,811	11,015,688
Gilpin	7	10,389	22	10,342	--	--	94,948
Ouray	485	674,564	3,067	1,417,157	4,748	3,513,688	6,502,850
San Miguel	1,285	1,788,705	6,121	2,827,991	10,233	7,572,416	14,801,857
Undistributed ³	593	825,604	15,862	7,328,165	22,732	16,821,958	44,881,170
Total	2,431	3,384,109	26,749	12,357,980	50,621	37,459,873	77,325,502

¹ Operations from which gold, silver, copper, lead, or zinc was recovered as byproducts from sand and gravel or from cleanup are not counted as mines.

² Does not include gravel washed.

³ Includes Dolores, Hinsdale, La Plata, Lake, Mineral, San Juan, and Teller Counties combined to avoid disclosing company proprietary data.

⁴ Data do not add to total shown because of independent rounding.

Table 9.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation and cyanidation ¹	17,151	15,954	--	--	--
Smelting of concentrates	33,303	4,038,654	2,420	26,745	50,621
Direct smelting of ore	235	28,563	11	4	1
Total	50,689	4,083,171	2,431	26,749	² 50,621
Placer					
Grand total	50,764	4,083,171	2,431	26,749	50,621

¹ Combined in 1976 to avoid disclosing company proprietary data.

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

Table 10.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ^{1 2}	Material sold or treated ³ (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold -----	6	36,317	4,054	4,643	8	10	(⁴)
Gold-silver -----	3	589	232	8,970	1	15	1
Silver -----	5	196,061	693	2,699,952	122	2,666	1,011
Total -----	14	232,967	4,979	2,713,565	131	2,691	1,012
Copper-lead-zinc -----	1	361,250	9,058	439,889	1,499	7,143	11,940
Lead -----	2	206	10	382	--	13	--
Lead-zinc -----	5	521,216	36,305	820,685	752	15,244	24,761
Zinc -----	1	178,945	337	108,650	49	1,659	12,908
Total ⁵ -----	9	1,061,617	45,710	1,369,606	2,301	24,058	49,610
Total lode ⁵ -----	21	1,294,584	50,689	4,083,171	2,431	26,749	50,621
Placer -----	2	--	75	--	--	--	--
Grand total -----	23	1,294,584	50,764	4,083,171	2,431	26,749	50,621

¹ Detail will not necessarily add to totals shown because some mines produce more than one class of material.

² Operations from which gold and silver are recovered as byproducts from sand and gravel operations are not counted as producing mines.

³ Does not include gravel washed.

⁴ Less than ½ unit.

⁵ Data may not add to totals shown because of independent rounding.

reached 4,853,619 tons of ore with 13,696,200 tons of waste removed.²² Sixty-one million pounds of molybdenum were recovered from both operations.²³ Installation of water reclaiming and purifying processes continued throughout the year. More than \$11 million will be expended on these projects.

Initial ore production, from development work, commenced July 8, 1976, at the Henderson mine in Clear Creek County. The processing facility in Grand County started up August 26, 1976. The operation produced 659,014 tons of ore during the year and treated an average of 5,000 tons per day by yearend.²⁴ By using a panel-caving mining system, full capacity of 30,000 tons of ore per day is expected to be attained in 1980, yielding 50 million pounds of molybdenum annually. In the last decade, approximately \$500 million was spent on this complex, which is the largest privately financed project in the history of Colorado.

The Professional Engineers of Colorado named the Henderson project as Colorado's Outstanding Engineering Achievement in 1976. The operation was cited for innovative design and execution of new concepts in plant siting, environmental safeguards, ore transport, and mining and milling methods. The operation, a major engineering achievement, has four shafts, the main shaft having a 28-foot finished diameter with a minimum 1-foot concrete lining and a 3,103-foot depth. To provide adequate space for the concentrator and tailings disposal area, and to meet environmental objectives, ore treatment facilities were constructed 14 miles west of the mine. The mine and processing plant are linked by an ore-haulage railroad that travels through a 9.6-mile-tunnel excavated under the Continental Divide and 4.8 miles on the surface.

Waste rock from the Henderson mine is used for landscaping and for stabilization of tailings piles at the Urad mine which closed in 1974. Reclamation of that 125-acre area is still underway. At the Henderson mill site, the reclamation program includes revegetating the construction roads. Also, the mill has a closed-loop industrial-mill-water circuit for recycling water.

Approximately 1,000 people are employed at the mine, and 200 to 300 people work at the mill and other areas of operation. Proven and probable reserves have

been estimated at 300 million tons of ore containing 0.49% MoS₂.²⁵

Climax Molybdenum Co. continued exploration for molybdenum on Mount Emmons near Crested Butte, Gunnison County.

Pyrite.—Pyrite was produced at the Climax mill of AMAX in Lake County as a byproduct of concentrating molybdenum ore.

Silver.—Output of silver from 21 operations in 12 counties increased 717,171 troy ounces (21%) above that of 1975. Average price of silver for the year was \$4.35 per troy ounce.

Eight mines had production exceeding 100,000 ounces. Principal producers were Homestake Mining Co.'s Bulldog Mountain mine at Creede and the Sherman Tunnel operated by Day Mines, Inc. Other important silver mines, in order of output, were the Idarado with 439,889 troy ounces, Leadville, Sunnyside, Emperius, Eagle, and Camp Bird. Leading counties in silver output, in order of production, were Mineral, Lake, San Miguel, San Juan, Ouray, and Eagle.

At its Bulldog Mountain mine in Creede, Homestake has been losing a considerable quantity of silver in the slime fraction. After experimental work with various leaching methods, a decision was made to construct the world's first carbon-in-pulp plant for recovery of silver—silver that had been going to the tailing pond. Work on the plant was begun in April and completed by yearend at a cost of more than \$2 million.

In a brochure²⁶ on the Creede operation, Homestake describes the process as follows, "The process consists of agitation leaching of slime tailings with lime and dilute cyanide solution in a thick pulp. Silver is dissolved and removed from the solution by agitating the pulp with granular carbon which adsorbs soluble silver. Processing makes use of a multiple-stage, counter-current system of screens and tanks to separate and advance carbon through the pulp stream. The cargon, which is rapidly loaded

²² World Mining. United States Tons of Ore Mined and Waste Stripped at Largest Open Pit Mines in 1974, 1975, 1976, and 1977. V. 31, No. 7, June 25, 1978, p. 201.

²³ AMAX Inc. Annual Report, 1976. P. 9.

²⁴ Work cited in footnote 22.

²⁵ AMAX Inc. AMAX Today. No date, p. 3.

²⁶ Homestake Mining Co. Colorful Creede, Colorado—1890's—Now Site of Homestake's Bulldog Mountain Silver Mine. 1977, 24 pp.

with silver, is separated and sent to a stripping cone where silver is eluted with a dilute hot caustic solution. Metallic silver is then recovered from the caustic solution by electroplating on cathodes of steel wool, which are melted down. Crude silver bullion is then poured into bars."

Since 1969, 300,000 tons of tailings, containing approximately 3 troy ounces of silver per ton, from the flotation circuit were deposited in the old tailings ponds. During the next 5 years, these tailings will be processed through the carbon-in-pulp plant.

A new tailings impoundment was completed in August at a cost of \$900,000. The dam, 90 feet high at the center, contains 325,053 cubic yards of compacted earth fill, 45,404 cubic yards of rock drain material, and 4,205 cubic yards of riprap.

Homestake became interested in the Bulldog Mountain property when the U.S. Geological Survey published information in 1960 on the potential of the Bulldog Mountain Fault Zone. Homestake leased properties from Bulldog Mountain, Inc., in 1963, and in June 1964 began an adit at the 9,700-foot level (levels at this mine are named according to their elevation above sea level). In August 1966 the 9,360-foot level (main haulage) was begun, and in April 1969 a flotation mill was completed. A concentrate containing silver, lead, zinc, and copper is produced at the mill. More than 300 tons of ore is treated each day, and about 89% of the silver and 82% of the lead are recovered. Silver recovery will be increased by the new carbon-in-pulp plant.

In addition to the 9,700- and 9,360-foot levels, the ore is developed by the No. 1 winze (460 feet deep) on the 9,360-foot level, the No. 2 winze, and the 9,200- and 9,000-foot levels. About 5,000 feet of drift is driven each year, and at yearend 8.5 miles of drifts were accessible on five levels. Homestake uses a 4-foot-diameter raise-boring machine to make connections and ore passes from stopes to haulage levels. Because of the fractured and unconsolidated nature of the ore, Homestake developed a unique underhand cut-and-fill mining method. Mining in the production stopes proceeds from the top down under a cemented sand fill.

In October 1974, Homestake completed

royalty payments to Bulldog Mountain, Inc., and acquired full ownership of the mine. Other claims have been purchased, including those held by Equity Mines, Inc. At yearend, ore reserves in these properties were 800,000 tons. Homestake also has a 50% interest in a joint venture (Creede Venture) to explore low-grade bedded silver deposits in the Creede Formation.

Homestake's brochure states that production for the year was 117,783 tons of ore which averaged 18.1 ounces of silver per ton and 2.5% lead. Metal contained in the concentrates produced amounted to 1,644,900 troy ounces of silver and 2,182 tons of lead. The Bulldog Mountain mine employs 136 people with a payroll exceeding \$1.9 million.

Tin.—Tin concentrate was produced as a byproduct at AMAX's Climax mill. Shipments were more than seven times greater than in 1975. Colorado was again the Nation's leading tin producer.

Tungsten.—Tungsten output in the State decreased 1.8% below that of 1975; however, because of higher prices for the commodity, the value of production increased by 22% over that of 1975. The tungsten output was obtained from the Climax mine of AMAX Inc. where tungsten concentrate is produced as a byproduct of processing molybdenum ore. Because of the increase in worldwide demand for tungsten concentrates, Climax installed new equipment to improve recovery of tungsten and tin. Colorado Tungsten Corp.'s mine and one other mine shipped a small amount of tungsten from Boulder County.

Uranium.—For the second consecutive year, uranium oxide (U_3O_8) from ores mined in the State decreased in quantity and increased in value over that of the previous year. The decrease in quantity was slight (6%) compared to the 45% increase in value. Colorado followed New Mexico, Wyoming, and Utah in ranking of production; in 1975 Colorado was ranked third. Colorado's production came from 78 operations in 8 counties—2 in Garfield, 3 in Jefferson, 14 in Mesa, 1 in Moffat, 39 in Montrose, 1 in Rio Blanco, 2 in Saguache, and 16 in San Miguel.

A \$20 million expansion of the uranium mill at Canon City was announced by Cotter Corp. The mill capacity is to be increased from 250 to 1,000 tons of ore per

day and is to take care of increased demands for uranium by Cotter's parent company, Commonwealth Edison of Illinois.

Homestake Mining Co. did more drilling and some experimental mining at the Pitch uranium properties in the Marshall Pass area. Some ore was shipped to the Cotter Corp. mill. Environmental and engineering studies at the mine site also were done. If the company can acquire the necessary State and Federal licenses and clearances, a mine-mill complex will be developed.

Ranchers Exploration and Development Corp. acquired the uranium mill tailings at Durango and Naturita from Foote Minerals Co. According to Ranchers 1976 annual report, the tailings consisted of 2 million tons of material containing 1.7 million pounds of uranium, of which about half may be recoverable by heap leaching.

In October, Wyoming Minerals Corp. was granted a special use permit by the Weld County Commission to conduct tests for solution mining of uranium. Earlier in the year, the company had obtained approval from the Weld County Planning Commission and a permit from the Colorado Water Quality Control Commission for underground disposal of wastes. The test site is on 7.5 acres about $3\frac{1}{2}$ miles southwest of Grover.

The Ute Mountain Indian Tribe and Mobil Corp. signed a contract for Mobil to explore for and develop uranium deposits on 162,176 acres of the Ute Mountain Reservation in Montezuma County. Mobil gave the tribal council checks totaling \$2,432,640 for bonus considerations and the first year's lease payment.

The Grand Junction office of the U.S. Energy Research and Development Administration (ERDA) held a Uranium Industry Seminar on October 19 and 20 in Grand Junction. Of the 547 persons attending the 2-day seminar, 210 represented domestic and foreign exploration companies, 93 represented State and Federal Government agencies and their contractors, 62 represented utility companies, 61 represented individual consultants and/or consulting firms, and the remainder represented universities and manufacturing, service, and investment companies.

Vanadium.—Uranium-vanadium ores mined in Colorado continued to supply a significant amount of U.S. vanadium pro-

duction, with Colorado ranking second among the five producing States in 1976. San Miguel and Montrose Counties contributed most of the State's production, followed by Mesa, Garfield, and Moffat Counties. The Uravan-Rifle mill complex of Union Carbide Corp. recovered vanadium oxide from the ores.

The Durita project of Ranchers Exploration and Development Corp. at Naturita, which involves the leaching of old uranium-vanadium mill tailings to recover both uranium and vanadium, plans to recover their first uranium yellowcake slurry in late 1977 and to activate a vanadium circuit in early 1978.

Zinc.—Zinc output increased by 2,161 tons (4.5%) over that of 1975. Value was down 1% because of the lower average zinc price, 37 cents per pound, for 1976; for 1975, the average price was 39 cents.

Nine counties had 12 operating mines. Lake County ranked first in production, followed, in order of output, by Eagle, San Miguel, San Juan, Ouray, and Mineral Counties. These six counties accounted for nearly all the State total.

Of the producing mines, six had outputs of over 1,000 tons. The largest producers were the Eagle mine, operated by New Jersey Zinc in Eagle County, and the Leadville mine, operated by ASARCO in Lake County. Other mines having more than 1,000 tons of output were the Idarado mine (Idarado Mining Co.) with 11,940 tons, Sunnyside mine (Standard Metals Corp.), Camp Bird mine (Federal Resources Corp.), and Emperius mine (Minerals Engineering Co.).

NONMETALS

Cement.—Portland and masonry cements were produced and shipped by Ideal Cement Co., a division of Ideal Basic Industries, Inc., and Dewey Rocky Mountain Cement Co., a division of Martin Marietta Corp.

Quantities of portland and masonry cement produced in 1976 were 17% and 21% greater, respectively, than in 1975. At year-end, cement stocks at mill were 33% lower than at yearend 1975. Higher production and decreased stocks reflected a general upturn in the level of activity of the State's economy, particularly the construction sector. Ready-mix concrete companies pur-

chased 68% of the portland cement. Other customers, in order of quantity, were highway contractors, concrete product manufacturers, and building material dealers. Ninety-four percent of the portland cement shipped from plants was by truck, and the balance was by rail.

Clays.—Output of clay came from 37 mines operated by 16 companies, compared with 45 mines operated by 21 companies in 1975. Since 1973, the peak year for mine count, the number of mines has dropped by 28. Four companies produced fire clay; 2, bentonite; and 12, common clay and shale. Production of common clay (including shale) in 1976 amounted to 450,202 tons valued at \$1,554,488, and fire clay output was 29,317 tons valued at \$421,722. The average unit price for common clay and shale was \$3.45 per ton, and that of fire clay was \$14.38 per ton.

Clay was produced in nine counties. Jefferson County had the greatest production of common clay and shale with 201,691 tons. Pueblo County was the major source of fire clay.

Fire clay was used for making refractories, common clay and shale were used for building brick and sewer pipe, and bentonite was used as a waterproof sealer.

The largest clay producer, Robinson Brick & Tile Co., operated 12 mines for common clay and shale in Douglas, Elbert, El Paso, and Jefferson Counties. The company operates two brick plants in Denver.

The second largest clay producer, Summit Pressed Brick & Tile Co., produced 52,380 tons of common clay and shale in Pueblo County and 29,000 tons in Las Animas County for use in its brick plant at Trinidad.

Feldspar.—Colonna & Co. produced feldspar by hand cobbing from pegmatites in the Rampart Range. The product was used for decorative aggregate.

Gypsum.—The Flintkote Co., Joe C. Lackey, U.S. Soil Conditioning Co., Quad-Honstein Joint Venture, and Ernest W. Munroe mined 214,635 tons of gypsum in 1976; the first three operations were in Fremont County, and the last two were in Larimer County. Output increased 16% above that of 1975. The Flintkote Co. calcined gypsum at its Coaldale plant at Florence in Fremont County. Output of calcined gypsum increased 31% above that

of 1975. Calcined gypsum was used in the manufacture of building products, principally wallboard material. Uncalcined gypsum was marketed as a soil conditioner and cement retarder.

Lime.—CF&I Steel Corp., The Great Western Sugar Co., American Crystal Sugar Co., and Holly Sugar Corp. produced lime at 10 plants in 10 counties for steel furnaces, sugar refining, and other uses. Leading counties were Pueblo, Morgan, Larimer, and Boulder. Output decreased 7% to 185,000 tons. The lime was used in Colorado.

Perlite.—The only crude perlite produced in Colorado was mined at the Rosita mine of Persolite Products, Inc., in Custer County. Perlite was expanded at two mills in Colorado: The Antonito in Conejos County, operated by Grefco, Inc., and the Florence in Fremont County, operated by Persolite Products, Inc. Source of the crude perlite for the Grefco mill was deposits in New Mexico.

Expand perlite was used principally as material for filter aid (79%). Other uses were for low-temperature insulation and horticulture aggregate and in concrete and plaster.

Pumice.—Output of pumice, in the form of volcanic cinder and scoria, decreased 13%, and value declined 22% from that of 1975. Scoria was produced by Colorado Aggregate Co., Inc., at Mesita Hill in Costilla County, and volcanic cinders were mined by Dotsero Block Co., Inc., from its mine near Gypsum in Eagle County. Major uses of pumice were for concrete aggregate and landscaping. Minor uses were road construction and roofing granules.

Salt.—Salt in the form of brine was recovered from a well in Montrose County by Union Carbide Corp. for use in the company's uranium-vanadium mill at Uranvan. Value of production was 33% over the value of production in 1975.

Sand and Gravel.—Production of sand and gravel in 1976 was slightly greater in quantity but less in value than in 1975. Of the mineral commodities produced in Colorado in 1976, sand and gravel was the eighth highest based on value of production. Of the nonmetal commodities mined in the State, only portland cement exceeded sand and gravel in value. The quantity and value of sand and gravel for 1976 listed in table 1

is that sold or used for construction purposes only. In addition, some sand was used for industrial purposes, mainly for oil hydrofracturing.

Of the 20.2 million tons of sand and gravel sold or used for construction purposes, 10.7 million tons, or 53%, was produced by commercial operators and 9.5 million tons, or 47%, by government agencies and their contractors.

The average price for construction sand and gravel was \$1.63 per ton. Processed sand averaged \$1.80 per ton, and processed gravel \$1.68. Unprocessed sand and gravel averaged \$0.89 per ton.

Of the State's 63 counties, only 6 (Costilla, Dolores, Gilpin, Mineral, Saguache, and San Juan) had no recorded production of sand and gravel. Jefferson County had the largest output, 4,162,000 tons. Other counties with greater than 1 million tons of production ranked according to output were Adams, Arapahoe, Boulder, and Mesa, and together with Jefferson County they accounted for about one-half of the State output.

Sand and gravel was produced at 232 operations by 209 individuals, companies, and government agencies. Eighty-three operations had outputs exceeding 100,000 tons, but none had 1 million tons or more. Jefferson and Arapahoe Counties had the most

operations, 18 each. Other counties having 10 or more operations were Boulder (11), El Paso (10), Larimer (14), and Mesa (11).

Stone.—Thirty-two counties had stone production from 111 quarries. Production of stone totaled 5.3 million tons, almost the same as in 1975.

Ten companies produced dimension stone for rubble, rough construction, house stone veneer, and other uses. Output increased 11% to 5,904 tons valued at \$198,000. Leading producers were Berthoud Pink Stone Co. and John W. Fitts.

Crushed stone was produced by 20 companies at 101 quarries for cement, concrete, flux stone, and other uses. Output was 5,293 million tons valued at \$12.4 million. Leading producers were Ideal Basic Industries, Inc., Martin Marietta Corp., and Cooley Gravel Co.

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

Vermiculite.—Crude vermiculite from Montana was exfoliated by W. R. Grace & Co. at its plant in Denver. The product was used for concrete and plaster aggregates, insulation, fireproofing and horticulture.

Table 11.—Colorado: Stone production, by county

County	1975			1976		
	Number of quarries	Quantity (short tons)	Value (thousands)	Number of quarries	Quantity (short tons)	Value (thousands)
Adams	3	1,066	\$2	6	9,307	\$18
Arapahoe	2	971	2	3	337	1
Boulder	8	884,279	787	13	1,033,559	1,411
Clear Creek	1	1,326	3	--	--	--
Delta	1	22	(¹)	--	--	--
Denver	2	3,419	7	2	7,084	14
Dolores	7	72,198	94	5	31,192	80
Douglas	2	W	W	6	12,362	39
Eagle	--	--	--	2	2,128	4
Elbert	--	--	--	2	841	2
El Paso	4	W	W	12	739,212	1,640
Fremont	8	1,826,377	3,298	7	1,650,220	3,425
Garfield	3	W	W	3	77,389	211
Grand	1	1,400	3	3	672	1
Gunnison	4	W	64	5	51,082	52
Huerfano	--	--	--	1	213	(¹)
Jackson	1	20	(¹)	--	--	--
Jefferson	8	735,281	1,541	4	807,400	1,655
Kit Carson	--	--	--	1	3,180	6
Lake	1	4,000	8	--	--	--
La Plata	5	43,289	88	--	--	--
Larimer	11	644,939	2,228	11	579,133	2,986
Las Animas	1	70	(¹)	2	876	2
Lincoln	2	5,711	11	6	2,982	6
Mineral	1	1,348	3	1	47	(¹)
Moffat	--	--	--	1	1,463	3
Montezuma	1	1,500	14	1	105	(¹)
Montrose	1	1,273	2	1	61	(¹)
Morgan	1	940	1	--	--	--
Prowers	--	--	--	2	4,300	8
Pueblo	1	4,723	9	--	--	--
Rio Blanco	1	1,274	4	2	482	1
Routt	1	2,622	13	--	--	--
San Juan	1	21,980	44	1	127	(¹)
San Miguel	1	W	45	--	--	--
Summit	2	7,313	14	--	--	--
Teller	--	--	--	1	527	1
Washington	--	--	--	1	273	1
Weld	1	4,000	6	1	78	(¹)
Other counties ²	5	1,043,458	2,649	5	281,981	988
Total	92	5,314,799	10,940	111	5,298,613	12,555

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

¹ Less than ½ unit.

² Includes Chaffee, Mesa, and Park (1976) Counties.

Table 12.—Colorado: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Cement manufacture	2,758	4,526	2,743	5,431
Concrete aggregate	549	1,421	694	1,786
Dense-graded roadbase stone	328	582	376	534
Riprap and jetty stone	352	949	248	667
Bituminous aggregate	212	323	211	305
Roadstone	155	216	206	518
Surface treatment aggregate	170	344	W	W
Lime manufacture ²	207	538	174	673
Terrazzo and exposed aggregate	2	14	8	17
Filter stone	W	W	W	W
Refractory stone	4	14	W	W
Other uses ³	W	W	2	W
Total	5,309	10,773	5,293	12,357

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

¹ Includes limestone, granite, sandstone, and miscellaneous stone.

² Includes sugar refining.

³ Includes stone used for flux stone, mine dusting, mineral food, other filler, waste material, macadam aggregate, agricultural limestone, unspecified uses (1975), and uses indicated by symbol W.

⁴ Data do not add to total shown because of independent rounding.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon dioxide (natural): Dye Carbonic, Inc -----	Box 816 Denver, Colo. 80201	Well -----	Montezuma.
Cement: Ideal Basic Industries, Inc. ¹ -----	Box 231 Florence, Colo. 81226	Plants -----	Fremont and Larimer.
Martin Marietta Corp. ¹ -----	11300 Rockville Pike Rockville, Md. 20852	-----do -----	Boulder.
Clays: George W. Parfet Estate, Inc.	Box 266 Golden, Colo. 80401	Mine -----	Jefferson.
Robinson Brick & Tile Co --	Box 1619 Denver, Colo. 80223	Mines -----	Douglas, Elbert, El Paso, Jefferson.
Summit Pressed Brick & Tile Co.	Box 14 Trinidad, Colo. 81082	-----do -----	Las Animas and Pueblo.
Coal, bituminous: CF&I Steel Corp. ² -----	Box 316 Pueblo, Colo. 81002	Mine -----	Las Animas.
Energy Fuels Corp -----	Box G Steamboat Springs, Colo. 80477	Strip mine, plant -	Routt.
Mid-Continental Coal & Coke Co.	Box 153 Carbondale, Colo. 81623	Mine, plant -----	Pitkin.
Peabody Coal Co -----	301 North Memorial Dr. St. Louis, Mo. 63102	Strip mines, plant.	Montrose and Routt.
Pittsburg & Midway Coal Mining Co.	Tenmain Center Kansas City, Mo. 64105	Strip mine, plant -	Routt.
United States Steel Corp --	Box 807 Dragerton, Utah 84520	Mine, plant -----	Gunnison.
Copper: Federal Resources Corp. ³ --	Ouray, Colo. 81427 -----	Mine -----	Ouray.
Idarado Mining Co. ⁴ -----	-----do -----	-----do -----	Ouray and San Miguel.
Standard Metals Corp. ⁴ --	Box 247 Silverton, Colo. 81433	-----do -----	San Juan.
Gypsum: Ernest W. Munroe -----	101 East Vine Dr. Fort Collins, Colo. 80521	-----do -----	Larimer.
Quad-Honstein Joint Venture.	1301 Arapahoe St. Golden, Colo. 80401	-----do -----	Do.
The Flintkote Co -----	400 Westchester Ave. White Plains, N.Y. 10604	Mine, plant -----	Fremont.
U.S. Soil Conditioning Co --	Box 336 Salida, Colo. 81201	Mine -----	Do.
Iron ore: Pitkin Iron Corp -----	105 West Adams St. Chicago, Ill. 60603	Strip mine, plant -	Pitkin.
Lead: ASARCO Incorporated ⁵ --	Box 936 Leadville, Colo. 80461	Mine -----	Lake.
Homestake Mining Co. ⁶ --	Box 98 Creede, Colo. 81130	-----do -----	Mineral.
Lime: The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Plants -----	Adams, Boulder, Larimer, Logan, Morgan, Sedgwick, Weld.
Molybdenum: AMAX Inc. ⁷ -----	13949 West Colfax Ave. Golden, Colo. 80401	Mine -----	Clear Creek and Lake.
Peat: Colorado Peat Industries --	6003 Indian Rd. Boulder, Colo. 80302	Bog -----	Boulder.
Universal Peat Co -----	1557 South Ingalls St. Lakewood, Colo. 80422	Bog -----	Park.
Ver-Ja Peat Moss -----	Woodland Park, Colo. 80863.	Bog -----	Teller.
Perlite (crude and expanded): Grefco, Inc -----	Box 308 Antonito, Colo. 81120	Plant -----	Conejos.
Persolite Products, Inc. ⁸ --	Box 105 Florence, Colo. 81226	Mine -----	Custer.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Petroleum (crude):			
Amoco Petroleum Corp ----	Box 591 Tulsa, Okla. 74102	Wells -----	Adams, Arapahoe, Cheyenne, Montezuma, Washington, Weld.
Beaver Mesa Exploration, Inc.	910 Metro Bank Bldg. Denver, Colo. 80202	----do -----	Adams and Weld.
Champlin Petroleum Co ---	Box 9365 Fort Worth, Tex. 76107	----do -----	Adams, Arapahoe, Cheyenne, Morgan, Washington, Weld.
Charter Exploration & Production Co.	1515 Arapahoe St. Denver, Colo. 80202	----do -----	Weld.
Chevron Oil Co -----	Box 599 1700 Broadway Denver, Colo. 80201	----do -----	Kiowa, Rio Blanco, Weld.
Continental Oil Co -----	Box 2197 Houston, Tex. 77001	----do -----	Jackson and Washington.
Inxco Oil Co -----	1100 Milam Bldg. Houston, Tex. 77002	----do -----	Cheyenne and Kiowa.
Texaco, Inc -----	Box 2100 Denver, Colo. 80201	----do -----	Adams, Arapahoe, Moffat, Rio Blanco.
Thomas G. Vessels -----	600 South Cherry St. Denver, Colo. 80222	----do -----	Adams, Arapahoe, Weld.
Pumice:			
Colorado Aggregate Co., Inc.	Box 106 Mesita, Colo. 81142	Strip mine and plant.	Costilla.
Dotsero Block Co., Inc ---	Box 933 Glenwood Springs, Colo. 81601	----do -----	Eagle.
Sand and gravel:			
Asphalt Material & Paving Co.	Golden, Colo. 80401	Pits, plants -----	Douglas, Garfield, Jefferson.
Brannan Sand & Gravel Co.	4800 Brighton Blvd. Denver, Colo. 80216	----do -----	Adams, Arapahoe, Jefferson.
Cooley Gravel Co. ¹ -----	Box 313 Pueblo, Colo. 81002	----do -----	Adams, Arapahoe, Pueblo.
L. G. Everist, Inc -----	313 South Phillips Sioux Falls, S. Dak. 57102	Pit -----	Jefferson.
Mobile Pre-Mix Sand and Gravel Co.	7620 Madison St. Denver, Colo. 80204	Pits, plants -----	Adams and Arapahoe.
Plains Aggregate Co ----	Box 229 Boulder, Colo. 80302	Pit -----	Larimer.
Western Paving Construc- tion Co.	5105 Washington St. Denver, Colo. 80216	Pit, plant -----	Adams.
Stone:			
Castle Concrete Co -----	Box 2379 Colorado Springs, Colo. 80901	Quarry, plant ----	El Paso.
Colorado Lien Co -----	Box 1961 Fort Collins, Colo. 80521	Quarry -----	Garfield and Larimer.
Uranium:			
Cotter Corp -----	Box 352 Golden, Colo. 80401	Mine -----	Fremont and Jefferson.
Union Carbide Corp. ⁹ ----	270 Park Ave. New York, N.Y. 10017	Mines -----	Garfield, Mesa, Montrose, San Miguel.
Zinc:			
The New Jersey Zinc Co. ¹⁰	Gilman, Colo. 81634	Mine, mill -----	Eagle.

¹ Also stone.² Also lime and stone.³ Also lead and zinc.⁴ Also gold, lead, silver, and zinc.⁵ Also gold, silver, and zinc.⁶ Also silver.⁷ Also pyrite, tin, and tungsten.⁸ Also a plant in Fremont County.⁹ Also vanadium.¹⁰ Also lead and silver.

The Mineral Industry of Connecticut

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Connecticut Geological and Natural History Survey for collecting information on all minerals except fuels.

By William R. Barton ¹

The value of minerals reported produced in Connecticut was \$34.3 million in 1976 compared with \$33.0 million in 1975. The increase primarily reflected general inflationary pressures in the national economy.

In order of declining value, Connecticut's principal 1976 mineral products were as follows: Stone, sand and gravel, feldspar, lime, clays, mica, and gem stones. The State also is the site of important copper and brass milling operations, and the manufacture of silverware, calcium metal, brick, and glass, all of which depend directly on products of the minerals industry.

Connecticut mineral production in 1976 was far below that required to sustain its economy. While the American economy requires about 40,000 pounds per person of new mineral materials annually, only

7,000 pounds per person was produced in the State for Connecticut's 3.1 million people. Connecticut manufacturing is heavily and directly dependent upon mineral raw materials. Of 418,700 persons employed in manufacturing (during 1973), more than 20% were employed in producing or fabricating stone, clays, glass, metal, and petroleum products. Those categories accounted for 22% of the total value added by all Connecticut manufacturing operations and consumed 29% of all raw materials used in the State.

In addition, these primary products provide the raw materials used by much of Connecticut's other industries such as manufacturing of machinery, transportation equipment, and electrical and electronic components—which account for

¹ State Liaison Officer, Bureau of Mines, Newmarket, N.H.

Table 1.—Mineral production in Connecticut ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons--	116	\$307	130	\$427
Lime -----do-----	23	1,013	24	1,103
Sand and gravel -----do-----	4,900	10,040	6,414	12,978
Stone -----do-----	7,332	20,117	6,016	17,598
Value of items that cannot be disclosed:				
Feldspar, gem stones, and mica -----	XX	1,533	XX	2,212
Total -----	XX	33,010	XX	34,318
Total 1967 constant dollars -----	XX	13,062	XX	P 12,337

P Preliminary. XX Not applicable.

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

Table 2.—Value of mineral production in Connecticut, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Fairfield -----	\$309	\$1,447	Sand and gravel.
Hartford -----	W	W	Stone, sand and gravel, clays.
Litchfield -----	4,930	5,539	Sand and gravel, stone, lime.
Middlesex -----	2,952	3,526	Feldspar, sand and gravel, stone, mica, clays.
New Haven -----	W	W	Stone, sand and gravel, clays.
New London -----	W	W	Sand and gravel, stone.
Tolland -----	W	W	Do.
Windham -----	739	W	Do.
Undistributed ¹ -----	24,082	23,807	
Total ² -----	33,010	34,318	

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 Connecticut business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands...	1,453	1,475	+1.5
Unemployment ----- do-----	133	139	+4.5
Employment (nonagricultural):			
Mining ----- do-----	(¹)	(¹)	(¹)
Manufacturing ----- do-----	389.8	395.6	+1.5
Contract construction ----- do-----	² 44.9	² 40.1	² -10.7
Transportation and public utilities ----- do-----	53.1	53.0	-.2
Wholesale and retail trade ----- do-----	251.0	255.9	+2.0
Finance, insurance, real estate ----- do-----	86.0	87.4	+1.6
Services ----- do-----	219.9	229.1	+4.2
Government ----- do-----	178.7	177.0	-1.0
Total nonagricultural employment ----- do-----	1,223.4	1,238.1	+1.2
Personal income:			
Total ----- millions...	\$21,086	\$22,929	+8.7
Per capita ----- do-----	\$6,802	\$7,356	+8.1
Construction activity:			
Number of private and public residential units authorized...	12,114	13,870	+14.5
Value of nonresidential construction ----- millions...	\$184.3	\$191.6	+4.0
Value of State road contract awards ----- do-----	\$39.1	\$128.0	+227.4
Shipments of portland and masonry cement to and within the State ----- thousand short tons...	637	582	-8.6
Mineral production value:			
Total crude mineral value ----- millions...	\$33.0	\$34.3	+4.0
Value per capita, resident population ----- do-----	\$11	\$11	--
Value per square mile ----- do-----	\$6,590	\$6,851	+4.0

^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.

Table 4.—Worktime and injury experience in the Connecticut mineral industry in 1976¹

	Men	Manhours	Fatal injuries	Fatal frequency rate	Non-fatal disabling injuries	Non-fatal disabling frequency rate	Nondisabling injuries	Nondisabling frequency rate
Sand and gravel:								
Surface -----	511	642,060	--	--	5	7.79	6	9.34
Office -----	97	111,527	--	--	--	--	--	--
Total -----	608	753,587	--	--	5	6.63	6	7.96
Stone:								
Surface -----	274	577,630	--	--	12	20.77	5	8.66
Mills -----	100	189,179	--	--	1	5.29	1	5.29
Office -----	38	84,129	--	--	--	--	--	--
Total -----	412	850,938	--	--	13	15.28	6	7.05
Clay:								
Surface -----	11	20,647	--	--	--	--	--	--
Mills -----	15	12,452	--	--	--	--	--	--
Office -----	2	5,280	--	--	--	--	--	--
Total -----	28	38,379	--	--	--	--	--	--
Feldspar:								
Surface -----	12	26,031	--	--	1	38.42	--	--
Mills -----	27	62,808	--	--	4	63.69	--	--
Office -----	6	12,150	--	--	--	--	--	--
Total -----	45	100,989	--	--	5	49.51	--	--
State totals:								
Surface -----	808	1,266,368	--	--	18	14.21	11	8.69
Mills -----	142	264,439	--	--	5	18.91	1	3.78
Office -----	143	213,086	--	--	--	--	--	--
Grand total -----	1,093	1,748,893	--	--	23	13.19	12	6.88

¹ Data supplied by Mine Safety and Health Administration, U.S. Department of Labor.

another 44% of total manufacturing, beyond the 22% accounted for by the primary mineral product consuming industries. This 66% share does not even take into account smaller metal fabricating industries such as jewelry, needles, and other miscellaneous categories. Additionally, Connecticut (1975 data) consumed 713 trillion Btu of energy—almost entirely from mineral fuels. Petroleum products supply 77% of energy raw material needs, while 13% was nuclear; 9%, natural gas; and only 1%, hydropower. Mineral fuels are not produced in Connecticut.

Construction started on two important mineral-related facilities during the year. The Connecticut Resource Recovery Authority plant at Bridgeport will cost an estimated \$53 million to complete and beginning in 1978 will produce glass, metals, and powdered fuel from 2,000 tons of trash per day. The powdered fuel will be used in conjunction with oil to generate electricity at the Bridgeport Harbor Station of United Illuminating Co. A \$21 million coal

gasification demonstration plant, two-thirds funded by Energy Research and Development Administration (ERDA), was being built by Combustion Engineering, Inc., at Windsor. During the year, Union Carbide Corp. and Texasgulf, Inc., both announced that they were moving their headquarters from New York City to Connecticut. Both Chase Brass and Copper Co. and the Brass Division of The Anaconda Co. announced closings of brass fabrication mills at Waterbury, due to age and high operating costs.

Legislation and Government Programs.—Coastal zone management programs were being devised by all of the New England coastal States as mandated by Federal coastal zone legislation. The plans impacted present and future mining with varying severity, but in all cases offered new restrictions or additional operational requirements that in the longrun would lessen the availability or increase the price of minerals essential to the New England economy.

A visitor guide to mining and mineral operations in the northeast, including Connecticut, was published.² The booklet described active and abandoned mining sites and camps that can be visited or easily viewed from major highways.

The Connecticut Geological and Natural History Survey published Quadrangle Report No. 34, the Bedrock Geology of the Newtown Quadrangle, by Rolph S. Stanley. The U.S. Geological Survey, in

cooperation with the Connecticut Geological and Natural History Survey, published map GQ-1320, Bedrock Geology of the Wales Quadrangle, by Victor M. Seiders. A 94-page report entitled "Surface Mining in Connecticut: The Public Need for Planning and Regulation for Sand and Gravel Operations" by William Valletta was issued by the Central Naugatuck Valley Regional Planning Agency, 20 East Main Street, Waterbury, Conn. 06702.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—There are no cement manufacturing plants in Connecticut. Data are not published on origin of cement shipments into the State, but the Hudson River Valley plant would seem to be a logical major source. Preliminary data on domestic cement shipments received in Connecticut indicate a 9% decrease in consumption of cement, from 636,651 tons in 1975 to 582,000 tons in 1976.

Clays.—Common clay was mined by four companies in Hartford, Middlesex, and New Haven Counties. Most of the clay was consumed in the manufacture of building brick; the rest was utilized by the ceramic and specialty clay products industry.

Feldspar.—The Feldspar Corp. mined feldspar from pegmatites at the Middletown and Hale mines and ground it at its Middletown plant in Middlesex County. The ground feldspar was shipped to various States and Canada for use in manufacturing glass and ceramic products. The Middletown operation is the largest feldspar producer in New England and continues to be a target of environmental groups and agencies critical of various facets of its operation.

Gem Stones.—Individuals, mineralogical clubs, and dealers collected specimens and bulk cutting and polishing material from mine dumps, quarries, and pegmatites

throughout the State, with most intense interest in the Middletown-Portland old beryl-mica district.

Lime.—At Canaan, Litchfield County, lime was produced by Pfizer, Inc. The product was sold for sewage treatment, mason's lime, and other uses. Production increased 4% in quantity and 9% in value from the levels of the previous year. The lime was consumed in New England and other States. Total consumption of lime in Connecticut was 55,023 tons.

Mica.—Sheet, scrap, and flake mica were byproducts of feldspar mining and processing in Middlesex County.

Sand and Gravel.—Sand and gravel was exceeded only by stone in both quantity and value among the mineral products excavated in Connecticut. Production of sand and gravel was reported in all eight counties in the State, led by Hartford and New Haven.

Of the 6.4 million tons of sand and gravel produced, 69% was reported sold or used commercially, and the rest was used in publicly funded projects. The production, 31% greater than that for 1975 in quantity, was used primarily as aggregate in either portland cement or bituminous concrete. Other uses were fill, railroad ballast, and foundry sand.

² U.S. Bureau of Mines Mining and Mineral Operations in the New England and Mid-Atlantic States. A Visitors Guide. BuMines SP10-76, 1976, pp. 5-11.

Table 5.—Connecticut: Construction sand and gravel sold or used

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	3,921	\$6,877	\$1.75
Gravel -----	2,492	6,099	2.45
Total ¹ -----	6,414	12,978	2.02

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

Table 6.—Connecticut: Construction sand and gravel sold or used by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	1,346	\$3,715	\$2.76
Concrete products (cement blocks, bricks, pipe, etc.) -----	925	2,037	2.20
Asphaltic concrete aggregates and other bituminous mixtures -----	1,042	2,392	2.30
Roadbase and coverings -----	1,213	2,182	1.80
Fill -----	1,654	2,134	1.29
Other uses -----	234	516	2.21
Total -----	6,414	¹ 12,978	2.02

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

Stone.—Eight companies quarried dimension stone for rough construction, rubble, rough blocks, and other uses. Output was 9,143 tons valued at \$215,000. Leading dimension stone producers were Castellucci & Sons, Inc., and R. V. Olson. Thirteen companies crushed stone at 18 quarries for bituminous aggregate, roadstone, concrete, and other uses. Output of crushed stone declined 18% to 6,007,000 tons valued at \$17,383,000. Leading crushed stone producers were Ashland Oil, Inc., Balf Co., and Roncari Industries, Inc.

Crushed basalt (including diabase), used chiefly as construction aggregate and railroad ballast, was the major stone product in both volume and value. It was produced in Hartford, Litchfield, and New Haven Counties and constituted an important export from Connecticut. It is barged to New York, New Jersey, and other destinations and carried by rail (for railroad ballast use) as far as Illinois. In

tonnage, it constituted the largest rail freight item originating in Connecticut. Among the States, Connecticut ranked fifth in output of crushed traprock.

Crushed limestone and dolomite were produced in Litchfield County by three operators. It was marketed for agricultural limestone, lime manufacturing, stucco, and filler. It also constituted the raw material basis for production of calcium at Canaan.

Crushed sandstone produced in Middlesex County was used in manufacturing fine aggregate and terrazzo. Quartz was produced in New London and Middlesex Counties for use in glass, terrazzo, asphalt and other industrial fillers, and as flux stone and abrasives. The quartz from Middlesex County was a byproduct of milling pegmatite ore for feldspar. The New London County quartz was produced from a large quartz replacement body at Lantern Hill. Dimension sandstone was produced in Windham County and sold for rubble and rough construction.

Table 7.—Connecticut: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	2,163	5,229	1,782	4,508
Roadstone -----	1,523	4,477	1,536	4,554
Concrete aggregate -----	1,785	4,221	1,256	3,177
Dense-graded roadbase stone -----	486	1,247	456	1,304
Surface treatment aggregate -----	687	1,797	197	616
Filter stone -----	W	W	71	216
Agricultural limestone -----	61	407	56	388
Macadam aggregate -----	50	113	35	85
Other uses ² -----	617	2,402	616	2,533
Total ³ -----	7,323	19,893	6,007	17,383

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

¹ Includes traprock, limestone, sandstone, and granite.

² Includes stone used for railroad ballast, lime manufacture, glass, riprap and jetty stone, exposed aggregate, stucco, flux stone, other filler, terrazzo, other uses, and uses indicated by symbol W.

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

Dimension granite was produced in Hartford, New Haven, New London, Tolland, and Windham Counties. It was sold as building stone veneer, rough blocks, rubble, flagging, curbing, ashlar, and irregular stone.

METALS

Pfizer, Inc., at Canaan, Litchfield County, was the only known commercial producer of calcium metal in the United States. Pfizer also was reported to have produced barium metal at Canaan.

There were six steel fabrication mills in the State, producing bars, rods, coils, strips, and wire rope from primary shapes. The Abbott Ball Co., Hartford County, produced steel shot and grit. Approximately 75 foundries produced ferrous and nonferrous castings, and 11 foundries produced ferrous and nonferrous forgings and ingots. Fabrication of copper and brass items remained a major Connecticut industrial activity during the year, as was silver crafting.

About 25 scrap metal dealers collected and processed ferrous metal for export and for sale to area foundries.

MINERAL FUELS

The Bureau of Mines published two reports detailing fuels and energy data by individual Eastern States including Connecticut.³ Another Bureau of Mines infor-

mation circular described the results of a June 1976 survey of planned or proposed energy facilities and related infrastructures.⁴

Both the In-O-Ven Corp. and Pepco International Inc. refinery proposals appeared to be stymied at the end of the year. While neither group officially announced withdrawal of their proposals, sustained opposition by organized groups of environmentalists have apparently arrested both plans in the preliminary stage. A proposal for a tanker terminal off New Haven also made little, if any, progress.

An ERDA contractor was developing a plan to drill in the Connecticut Triassic Valley in order to evaluate its uranium potential. Much of the planned drilling would be at the sites of former copper mines.

Statistics on Connecticut fuel consumption are published annually by the New England Fuel Institute in the March issue of Yankee Oilman. Data for 1974 were published in 1976.

³ Crump, L. H. Historical Fuels and Energy Consumption Data, 1960-72. United States by States and Census Districts East of the Mississippi. BuMines IC 8704, 1976, 456 pp.

— Fuels and Energy Data: United States by States and Census Divisions, 1973. BuMines IC 8722, 1976, 112 pp.

⁴ U.S. Bureau of Mines. Projects to Expand Fuel Sources in Eastern States. Survey of Planned or Proposed Coal Mines, Coal and Non-coal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilities, and Related Infrastructure, in States East of the Mississippi River (as of June 1976). BuMines IC 8725, 1976, 114 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Keller Pottery Corp. of Connecticut.	Four Rod Rd. Kensington, Conn. 06037	Pit -----	Hartford.
Kelsey-Ferguson Brick Co. (Div. of Susquehanna Corp.)	Route 5 East Windsor Hill, Conn. 06028	Pit -----	Do.
The Michael Kane Brick Co.	654 Newfield St. Middletown, Conn. 06475	Pit -----	Middlesex.
Plasticrete Corp., Stiles Brick Div.	Box 248 North Haven, Conn. 06478	Pit -----	New Haven.
Feldspar: The Feldspar Corp. ¹	Spruce Pine, N.C. 28777	Pits and plant ----	Middlesex.
Lime: Pfizer, Inc. ²	Daisy Hill Rd. Canaan, Conn. 06018	Pit and plant ----	Litchfield.
Sand and gravel:			
Beard Sand and Gravel Co., Inc.	127 Boston Post Rd. Milford, Conn. 06460	Pit -----	New Haven.
Genestra Sand & Gravel	260 Picket Rd. New Milford, Conn. 06776	Pit -----	Litchfield.
Leverly & Hurley	260 Bostwick Ave. Bridgeport, Conn. 06605	Pit -----	New Haven.
Loma Sand & Gravel Co.	Box 277 Newtown, Conn. 06470	Pit -----	Fairfield.
E. Powell Kovaks & Co.	Box 62 Brookfield, Conn. 06805	Pit -----	Do.
R. A. Rawson Sand and Gravel.	RFD #1 Putnam, Conn. 06260	Pit -----	Windham.
J. Romanella & Sons	Rt. 49 Dunns Corner, R.I. 02854	Pits -----	New Haven and Windham.
Roncari Industries, Inc. ³	1776 South Main St. East Granby, Conn. 06026	Pit -----	Hartford.
Windham Sand & Stone, Inc.	Box 346 Willimantic, Conn. 06226	Pit -----	Windham.
Silica, ground and crushed:			
Ottawa Silica Co	Box 577 Ottawa, Ill. 61350	Pit and plant ----	New London.
Stone: Basalt, crushed and broken:			
Balf Co. ⁴	Box 11190 Newington, Conn. 06111	Quarry -----	Hartford.
New Haven Traprock/Tomasso (Div. of Ashland Oil, Inc.) ⁵	Box 5033 Hamden, Conn. 06518	Quarries -----	Hartford and New Haven.
Oneglia & Gervasini Building Materials.	Box 907 Torrington, Conn. 06790	Quarry -----	Litchfield.
York Hill Trap Rock Quarry Co.	Westfield Rd. Meriden, Conn. 06450	----do -----	New Haven.

¹ Also crude mica and ground and crushed silica.² Also limestone and dolomite.³ Also basalt.⁴ Also sand and gravel.⁵ Also crushed granite.

The Mineral Industry of Delaware

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all minerals except fuels.

By Joseph A. Sutton ¹

The value of mineral production in Delaware in 1976 was \$1.8 million, slightly below the \$1.9 million recorded for the previous year. Of the minerals produced in the State, sand and gravel was produced in the largest quantity and was the mineral commodity that had the greatest value.

Other mineral-related activities included

the recovery of sulfur from petroleum refining and the calcining of gypsum. These mineral products were recovered from raw materials produced outside the State and were not counted as part of Delaware's mineral production.

¹ State Liaison Officer, (Delaware and Maryland), Bureau of Mines, Washington, D.C.

Table 1.—Mineral production in Delaware ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons--	9	\$6	11	\$8
Sand and gravel -----do-----	976	1,900	1,117	1,829
Total -----	XX	² 1,906	XX	² 1,837
Total 1967 constant dollars -----	XX	754	XX	^p 660

^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 gem stones and magnesium compounds, which must be concealed to avoid disclosing individual company confidential data.

Table 2.—Indicators of Delaware business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands	¹ 246.4	¹ 259.0	+5.1
Unemployment ----- do	21.2	23.0	+8.5
Employment (nonagricultural):			
Mining ----- do	(²)	(²)	(²)
Manufacturing ----- do	65.7	69.2	+5.3
Contract construction ----- do	14.5	14.4	-.7
Transportation and public utilities ----- do	11.8	11.9	+.8
Wholesale and retail trade ----- do	50.3	51.5	+2.4
Finance, insurance, real estate ----- do	10.9	11.0	+.9
Services ----- do	^{1,3} 36.4	^{1,3} 38.4	³ +5.5
Government ----- do	40.3	40.4	+.2
Total nonagricultural employment ----- do	229.9	236.8	+3.0
Personal income:			
Total ----- millions	\$3,756	\$4,092	+8.9
Per capita ----- do	\$6,483	\$7,030	+8.4
Construction activity:			
Number of private and public residential units authorized	3,040	2,647	-12.9
Value of nonresidential construction ----- millions	\$20.9	\$29.4	+40.7
Value of State road contract awards ----- do	\$25.3	\$19.8	-21.7
Shipments of portland and masonry cement to and within the State ----- thousand short tons	129	149	+15.5
Mineral production value:			
Total crude mineral value ⁴ ----- millions	\$1.9	\$1.8	-5.3
Value per capita, resident population ⁴ ----- \$	\$3	\$3	-.7
Value per square mile ⁴ ----- do	\$927	\$893	-3.7

^p Preliminary.

¹ Because of a difference in the method of determining the total civilian labor force and total nonagricultural employment, these figures appear to conflict; they are reproduced as published in two different publications of the Department of Labor. Resolution of the apparent conflict is possible only by detailed analysis of the data base from which each figure has been derived.

² Included with "Services."

³ Includes "Mining."

⁴ Partial figure, excludes value of gem stones and magnesium compounds, which must be withheld to avoid disclosing individual company confidential data.

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 Delaware Geological Survey continued to be the State's cooperator with the Federal Bureau of Mines in a formal program dealing with mineral production data. Work under a grant from the Bureau of Mines for detailed research on the properties and applications of glauconite was begun in 1976 and was scheduled for completion in 1977.

For about 2 years, Delaware has been developing a coastal management program under the auspices of the Federal Coastal Zone Management Act of 1972. The program is to provide a systematic approach to decision-making regarding the use of Delaware's coastal lands and waters in a manner that will provide reasonable use while conserving the irreplaceable resources of Delaware's coastal zone.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Clays.—The Delaware Brick Co., the only producer of clay in Delaware, produced 11,000 tons of common clay in 1976, an increase of 22% compared with that of 1975. The clay, which was used to make brick, was produced just south of New Castle. The unit value of the clay was 6 cents per ton higher in 1976 than that of 1975. The average unit value of the clay was 70 cents per ton.

Gypsum.—Georgia-Pacific Corp. calcined gypsum in New Castle County. Output increased 23% above that of 1975.

Magnesium Compounds.—The Barcroft Co. plant at Lewes continued to produce magnesium hydroxide (milk of magnesia) from sea water.

Sand and Gravel.—Production of sand and gravel in 1976 was 14% above that of 1975. The increase was mainly due to greater demand for unprocessed sand and

gravel used as roadbase and fill on unpaved roads.

The value of sand and gravel in 1976 was 4% below that of the previous year. Shipments of processed sand and gravel to nonresidential construction projects, which was valued at \$3.25 per ton, were 9% below that of 1975. The decrease was the main cause for the lower value reported for sand and gravel.

Production of sand and gravel was reported by 10 companies operating 12 pits

and 9 dredging operations in 2 of the State's 3 counties. New Castle County contained 10 of the 12 pits operated in the State, and Kent County contained 2 pits and all 9 of the dredging operations. Of the sand and gravel produced, 275,087 tons valued at \$833,435 was processed, and 842,150 tons valued at \$995,108 was unprocessed. The State government purchased 13% of the sand and gravel produced in the State; the rest was sold to commercial and private sectors.

Table 3.—Principal producers

Commodity and company	Address	Type of activity	County
Clays: Delaware Brick Co ----	River Rd. New Castle, Del. 19720	Pit -----	New Castle.
Gypsum, calcined: Georgia-Pacific Corp.	900 SW. Fifth Ave. Portland, Oreg. 97204	Plant -----	Do.
Magnesium compounds: Barcroft Co.	Box 474, Henlopen Dr. Lewes, Del. 19958	----do -----	Sussex.
Sand and gravel:			
Barber Sand and Gravel --	R.F.D. 1 Harrington, Del. 19952	2 Dredges -----	Kent.
Clough & Caulk Sand & Gravel.	Route 1, Box 129 Wyoming, Del. 19934	Pit -----	Do.
Contractor Sand & Gravel Co.	Box 2630 Wilmington, Del. 19805	4 Pits -----	New Castle.
Delaware Sand & Gravel Co.	R.D. 2 Box 286 New Castle, Del. 19720	Pit -----	Do.
Dover Equipment & Machine Co.	113 E. 6th St. Dover, Del. 19901	2 Dredges -----	Kent.
George Nashold, Inc -----	Box 286 Frederica, Del. 19946	3 Dredges -----	Do.
Parkway Gravel, Inc -----	4048 New Castle Ave. New Castle, Del. 19720	4 Pits -----	New Castle.
Staytons Select Borrew Pit.	R.D. 1, Box 305 Felton, Del. 19943	Pit -----	Kent.
Warren Bros. Tarburton Pit.	Box 868 Dover, Del. 19901	2 Dredges -----	Do.
Whittington's Sand & Gravel Co.	U.S. Route 40 Bear, Del. 19701	Pit -----	New Castle.

The Mineral Industry of Florida

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Florida Bureau of Geology.

By John W. Sweeney¹ and Charles W. Hendry, Jr.²

The value of mineral production in Florida decreased from \$1.7 billion in 1975 to \$1.6 billion in 1976; the decrease was principally caused by decreases in the value of phosphate rock.

Of the 49.2 million tons of phosphate rock produced in the United States, Florida and North Carolina produced 41.5 million tons. Of this total, Florida was the predominant producer and, for the 83d consecutive year, supplied more than any other State. The State ranked first in the value of phosphate rock, fuller's earth and

titanium concentrate production and fifth, in the value of peat production. Staurolite and zircon concentrate were produced only in Florida. Florida and North Carolina supplied 84% of the domestic phosphate rock market and most of the exports from the United States. Phosphate rock was exported from the ports of Tampa, Boca Grande, and Jacksonville. The principal recipients were Canada, Japan, and France.

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² Chief, Bureau of Geology, Florida Department of Natural Resources.

Table 1.—Mineral production in Florida¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland -----thousand short tons--	1,721	\$62,525	1,949	\$67,832
Clays -----do-----	712	17,063	680	20,672
Lime -----do-----	199	7,708	179	7,798
Natural gas -----million cubic feet--	44,383	43,185	43,165	42,358
Peat -----thousand short tons--	82	1,037	79	1,237
Petroleum (crude)-thousand 42-gallon barrels--	41,877	490,258	44,460	499,573
Sand and gravel -----thousand short tons--	13,237	20,199	13,204	19,164
Stone ² -----do-----	39,071	73,372	38,606	74,412
Value of items that cannot be disclosed:				
Cement (masonry), magnesium compounds, natural gas liquids, phosphate rock, rare-earth minerals (monazite), concentrate, staurolite, stone (dimension), titanium concentrate (ilmenite and rutile), and zircon concentrate -----	XX	1,060,153	XX	919,106
Total -----	XX	1,775,500	XX	1,652,232
Total 1967 constant dollars -----	XX	702,565	XX	P 593,977

^P Preliminary. 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Florida, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Alachua -----	\$2,404	\$1,629	Stone.
Bay -----	474	470	Sand and gravel.
Bradford -----	W	W	Natural gas liquids.
Brevard -----	W	1,321	Stone, sand and gravel.
Broward -----	11,093	8,711	Do.
Calhoun -----	--	W	Sand and gravel.
Charlotte -----	--	W	Sand and gravel, stone.
Citrus -----	1,881	2,700	Stone, phosphate rock.
Clay -----	30,566	31,572	Zircon, ilmenite, rutile, staurolite, sand and gravel, clays, monazite.
Collier -----	2,384	14,920	Petroleum, stone, natural gas.
Dade -----	65,143	W	Cement, stone, sand and gravel.
Dixie -----	W	W	Stone.
Escambia -----	759	86,031	Petroleum, natural gas, sand and gravel.
Gadsden -----	W	W	Clays, sand and gravel.
Glades -----	W	W	Sand and gravel.
Gulf -----	W	W	Magnesium compounds, lime.
Hamilton -----	W	W	Phosphate rock.
Hendry -----	W	35,555	Petroleum, sand and gravel, natural gas, stone.
Hernando -----	W	W	Stone, cement, lime, clays.
Highlands -----	358	356	Peat.
Hillsborough -----	W	W	Cement, stone, sand and gravel, peat.
Jackson -----	W	W	Stone, sand and gravel.
Lake -----	2,925	2,273	Sand and gravel.
Lee -----	W	13,267	Petroleum, stone, natural gas.
Leon -----	W	W	Sand and gravel.
Levy -----	290	877	Stone.
Manatee -----	W	W	Cement, stone.
Marion -----	6,092	6,532	Stone, clays, sand and gravel, phosphate rock.
Monroe -----	881	W	Stone.
Nassau -----	W	W	Titanium, zircon, monazite.
Okaloosa -----	W	W	Sand and gravel.
Okeechobee -----	W	--	
Orange -----	W	W	Peat.
Osceola -----	--	144	Stone.
Palm Beach -----	W	120	Do.
Pasco -----	343	999	Do.
Pinellas -----	W	--	
Polk -----	W	W	Phosphate rock, sand and gravel, stone.
Putnam -----	2,079	W	Clays, sand and gravel, peat.
St. Lucie -----	W	295	Sand and gravel.
Santa Rosa -----	W	450,331	Petroleum, natural gas liquids, natural gas, sand and gravel.
Sarasota -----	W	1,327	Sand and gravel.
Sumter -----	W	W	Stone, lime, peat.
Suwannee -----	2,643	W	Stone.
Taylor -----	578	W	Do.
Wakulla -----	1	W	Sand and gravel.
Walton -----	269	W	Do.
Undistributed ² -----	1,644,341	992,306	
Total ³ -----	1,775,500	1,652,232	

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

¹The following counties are not listed because no production was reported: Baker, Columbia, De Soto, Duval, Flagler, Franklin, Gilchrist, Hardee, Holmes, Indian River, Jefferson, Lafayette, Liberty, Madison, Martin, St. Johns, Seminole, Union, Volusia, and Washington.

²Includes values of counties indicated by symbol W.

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

Table 3.—Indicators of Florida business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	3,472.0	3,476.0	+0.1
Unemployment ----- do-----	370.0	314.0	-15.1
Employment (nonagricultural):			
Mining ----- do-----	9.6	9.2	-4.2
Manufacturing ----- do-----	336.5	343.1	+2.0
Contract construction ----- do-----	181.4	167.0	-7.9
Transportation and public utilities ----- do-----	182.7	180.6	-1.1
Wholesale and retail trade ----- do-----	716.4	727.1	+1.5
Finance, insurance, real estate ----- do-----	187.9	188.0	+1
Services ----- do-----	588.2	615.8	+4.7
Government ----- do-----	547.4	552.0	+0.8
Total nonagricultural employment ----- do-----	2,750.1	2,782.8	+1.2
Personal income:			
Total ----- millions--	\$46,320	\$50,690	+9.4
Per capita ----- do-----	\$5,596	\$6,020	+7.6
Construction activity:			
Number of private and public residential units authorized ----- do-----	47,989	66,691	+39.0
Value of nonresidential construction ----- millions--	\$802.3	\$879.5	+9.6
Value of State road contract awards ----- do-----	\$268.7	\$280.0	+4.2
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	3,404	3,569	+4.8
Mineral production value:			
Total crude mineral value ----- millions--	\$1,775.5	\$1,652.2	-6.9
Value per capita, resident population ----- do-----	\$214	\$196	-8.4
Value per square mile ----- do-----	\$30,246	\$28,214	-6.7

^p Preliminary.

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

The Federal Energy Administration (FEA) ordered Tampa Electric Co. to convert four of its Gannon Station generators back to coal and install pollution abatement equipment. The company has previously optioned to burn oil to meet air quality standards. Tampa Electric also announced plans to construct a coal-fired, 850-megawatt powerplant in southwest Hillsborough County. Construction is anticipated to begin in 1980, with a projected plant opening in 1985.

Florida Power Corp. announced it expects to start burning coal in powerplants having 877,000 kilowatts of generating capacity that are currently burning oil.

Florida Mining & Materials Corp. converted its new cement mill near Brooksville to a coal-burning plant. The cost of the conversion was approximately \$1.5 million.

Florida Power & Light Co.'s third nuclear powerplant came onstream. The St. Lucie Unit No. 1 at Hutchinson Island has a capacity of 802,000 kilowatts and was constructed at a cost of \$480 million. Another unit, St. Lucie No. 2, is being constructed adjacent to the first and is scheduled for completion in the early 1980's.

Florida Power Corp.'s 825-megawatt nuclear plant at Crystal River was near completion and expected to go onstream in early 1977.

Cape Canaveral has been selected as the American headquarters of the International Solar Energy Society.

Belcher Oil Co. proposed building a small refinery at Port Manatee. The small crude splitter would process about 15,000 barrels of crude oil per day and cost about \$2.5 to \$3 million and would employ 10 to 20 persons.

Exxon Corp., Texaco, Inc., and Gulf Oil Corp. are the only petroleum companies returning leases in the eastern Gulf of Mexico. The reclaimed leases are in the Destin anticline where only dry holes have thus far been drilled.

The first stratigraphic test well was scheduled in the southeast Atlantic waters in an area known as the Georgia Embayment. The 16,000-foot test well to be drilled 74 miles east of Jacksonville will be to gather geological data prior to Outer Continental Shelf (OCS) leasing.

A partnership of Mobile Oil Corp. and Amerada-Hess Corp. purchased four OCS

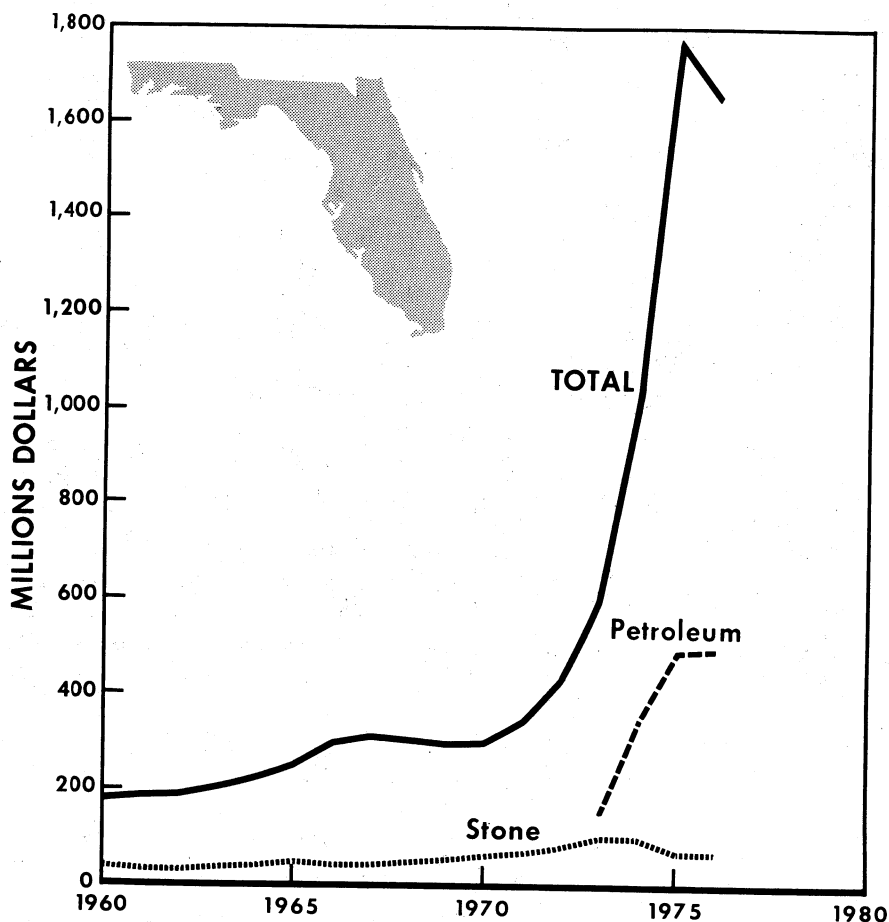


Figure 1.—Value of petroleum, stone, and total value of mineral production in Florida.

tracts off the central Florida coast for \$4 million. The four tracts are about 100 miles west of the Bradenton-Sarasota area.

The Florida Cabinet approved oil company requests to drill 15 exploratory wells in the Big Cypress Swamp. To win approval, the oil companies had to agree to remove the drilling pads, water wells, and access roads at the conclusion of the operation.

Dolime Minerals announced it was considering constructing a sulfur facility at Port Manatee. Dolime plans on importing sulfur from Canada, melting it at the Port Manatee facility, and shipping it molten to the Polk County fertilizer users. The

operation would process about 200,000 tons of sulfur annually.

Two contracts have been let on deepening the Tampa harbor from 34 feet to 43 feet with funds authorized by Congress in 1974. The revised cost of the 43-foot channel is now \$120 million.

The Jacksonville Port Authority will issue up to \$50 million in tax-free bonds for Occidental Chemical Co. to build loading facilities at the Port of Jacksonville. Occidental previously announced the deal under which it will sell the U.S.S.R. 1 million tons per year of superphosphoric acid for 20 years in return for ammonia. The new facilities will have a capacity to store 90,000

tons of superphosphoric acid. Forty thousand tons of dry fertilizer and 30,000 tons of ammonia are to be received from the U.S.S.R. in the purchase-trade agreement.

Florida Steel Corp. announced plans to increase its capacity by 185,000 tons by 1980.³

Legislation and Government Programs.—The Florida House of Representatives passed SB 950 which provides that no State pollution control standard which is more stringent than a comparable Federal standard can be enforced by the Department of Environmental Regulation unless approved by the Cabinet.

The State of Florida paved the way for a bigger involvement in international commerce by signing into law a bill to establish free trade zones in the State. The bill empowers corporations or Government agencies, such as cities or counties or other Government entities, to apply to the Federal Government to set up a free trade zone. In the trade zone, companies could import goods, store them there or assemble or process them, and export again to foreign nations with no U.S. or State tariff requirements. The goods or products must never leave the trade zone, however.

A U.S. District Court judge ruled that the Interior Department should immediately issue preferential rights leases to Kerr-McGee Chemical Corp. for its applications on land in the Osceola National Forest. The order brought protests from U.S. Senator Richard Stone and Florida's Attorney General Robert Shevin. Each urged the Interior Department to appeal the circuit court decision and postpone the letting of the leases until the ongoing Departmental study on the effect that mining would have on water quality and wildlife is completed.

The Council on Environment Quality recommended that the Environmental Protection Agency (EPA) prepare an environmental impact statement (EIS) on the current and projected development of the central Florida phosphate industry. It was determined that the proposed new phosphate expansions requiring Federal permits will have a potentially significant effect on the quality of human environment. The study to be conducted by EPA's Atlanta regional office, is expected to take 18 months

to complete and will provide economic and social analyses of the potential impacts on the region of the phosphate industry. Texas Instruments, Inc., was awarded a contract to develop the information necessary for the draft central Florida phosphate industry EIS. Upon completion of the draft EIS, public hearings will be held before the final EIS is prepared. The Federal Bureau of Mines cooperated with the contractor and furnished information on reserves and resources of phosphate rock and forecast production plans to the year 2000 in the central Florida area.

A moratorium due to the EIS preparation was not established. All existing operations continued. No Federal permits for new operations will be let until the study has been completed.

The EPA released EPA-520/4-76-018 "A Preliminary Evaluation of the Control of Indoor Radon Daughter Levels in New Structures." The report states that construction modification can reduce radiation levels to acceptable limits in homes constructed on reclaimed phosphate lands where radiation levels are above that allowed by the Surgeon General.

The EPA also released EPA-520/5-76-014 "Radon Dose Estimates to Phosphate Industry Personnel" which concluded that "all measured direct gamma exposures, even assuming continuous occupancy, are below the current Radiation Protection Guides of 0.5 rem per year for individual members of the population."

The U.S. Geological Survey in cooperation with the Southwest Florida Water Management District, Suwannee River Water Management District, and the Florida State Department of Environmental Regulation released a report assessing Radium-226 in Florida waters.⁴

The Florida Resource Recovery Council conducted a statewide energy recovery feasibility study evaluating the potential for producing fuels via solid waste conversion systems for use in utility powerplants and in industrial and institutional boilers.

³ Engineering and Mining Journal. Iron and Steel Demand Off in '76; Moderate Recovery Projected for '76. V. 177, No. 3, March 1976.

⁴ Irwin, G. A., and C. B. Hutchinson. Reconnaissance Water Sampling for Radium-226 in Central and Northern Florida, December 1974—March 1976. U.S. Geological Survey WRI 76-103, October 1976, 16 pp.

Several reports and articles were also published.⁵

In 1976, the Florida State Energy Office was awarded a grant by the FEA to write an energy conservation plan for Florida as required by the Energy Policy and Conservation Act of 1975.

Two advisory groups to the State Energy Office were established: Ten Regional Action Committees (REAC's) and the State Energy Advisory Council (SEAC). The Energy Office published a statistical report detailing energy use in Florida.⁶

Governor Askew formed a Governor's task force to recommend to the Legislature the organization structure to qualify Florida for Federal funds to implement a Coastal Zone Management Program.

The Florida House of Representatives passed (H4014) which requires the issuance of permits by the Department of Environmental Regulation before developers could dredge or fill Florida's coastal marshes.

The Florida Legislature amended Florida Statutes 17-3.04(2) (a) 2.a Effluent Standards for Phosphate Rock Subpart R—Phosphate Rock Subcategory Florida Administrative Code for the purpose of establishing effluent guidelines and standards for mining and processing phosphate rock.

The Florida Department of Environmental Regulation promulgated regulations on the discharge of effluents from phosphate settling areas into State streams and other bodies of waters. The regulation limits the particulate matter that these discharges contain.

The Federal Bureau of Mines awarded a grant to the Florida Bureau of Geology to inventory and categorize mined central Florida phosphate lands to determine the relationship between mined lands, reclaimed lands, and waste disposal areas and elevated radiation levels attributed to these areas. The study will be correlated with an ongoing EPA program studying radiation levels in structures built on "reclaimed" phosphate lands.

A cooperative research project to develop methods of dewatering phosphatic clay-slims continued through 1976. The phosphatic clays research project was jointly funded by the Federal Bureau of Mines and the Florida Phosphate Council, representing 10 phosphate rock mining companies. The Bureau of Mines programs were conducted at the Tuscaloosa Metallurgy

Research Center. During the year, research on the effects of reagents on dewatering slimes, filtration behavior as related to slime composition, dewatering phosphate slimes by static filtration and gel methods, and scanning electron microscope studies was carried out. Research grants at Auburn University to promote channeling in a continuous gravity sedimentation process and at the Florida State University to investigate flocculation and settling in phosphate slimes using scanning electron microscope techniques were funded through the project. Several field tests evaluating sand slime layering techniques and flocculation were evaluated during the year.

The Bureau's Albany Metallurgy Research Center, Albany, Oreg., continued for the third year its program on direct acidulation of Florida phosphate matrix. Preliminary data indicate that 92% to 96% of the P_2O_5 content of the matrix is recoverable and the P_2O_5 concentration in the product acid ranged from 21% to 30%. The waste filter cake appears suitable for use in land reclamation.

Characterization and beneficiation studies on the phosphate-bearing Hawthorne Formation were also conducted at the Bureau's Tuscaloosa Metallurgy Research Center. The project, a cooperative program with the Florida Bureau of Geology, is to determine if the phosphorite in the Hawthorne Formation is amiable to beneficiation.

The Bureau of Mines was awarded U.S. patent 4,000,067 for a process that enhances

⁵ Everett, K. J. Transfer Stations in Florida. State of Florida Resource Recovery Council, Res. Recovery/Solid Waste Tech. Assistance Ser., Rept. No. 1, May 1976, 51 pp.

———. "What's in the Garbage?" Municipal Solid Waste Composition in Florida. State of Florida Resource Recovery Council, Res. Recovery/Solid Waste Tech. Assistance Ser., Rept. No. 3, September 1976, 43 pp.

Everett, K. J., and J. W. Roy. Solid Waste Sampling Developing a Post Collection/Pre-Processing Methodology. State of Florida Resource Recovery Council, Res. Recovery/Solid Waste Tech. Assistance Ser., Rept. No. 2, April 1976, 19 pp.

Florida Environmental and Urban Issues. Resource Recovery: A Choice for Florida? May-June 1976, pp. 1-5.

Journal, Florida Engineering Society. Should All Our Waste Go To Waste? April 1976, p. 24.

Resource Recovery Council. Energy Recovery From Solid Waste: A Resource Recovery Solution for Florida. March 1976, 173 pp.

Roy, J. W. Integrated Waste Utility System. Res. Recovery/Solid Waste Tech. Assistance Ser., Rept. No. 5, 1976, 9 pp.

⁶ State Energy Office, Department of Administration. Statistics of the Florida Electric Utility Industry 1960 Through 1975. September 1976, 253 pp.

the rate of settling of fine particles in phosphate rods slime by adding optimum proportions of various fluorine compounds.

The Florida Bureau of Geology, Department of Natural Resources, continued studies of mineral resources and hydrology throughout the State during the year.

Waste Management, Inc., and the Federal Energy Research and Development Administration (ERDA) signed an agreement for the design, construction, and operation of

an experimental facility to convert urban solid waste into methane gas. This new facility is expected to cost \$2.5 million and will be constructed on the site of the company's existing waste shredding facility in Pompano Beach. The plant is expected to process up to 100 tons of garbage per day, producing gas through a bacterial digestion and fermentation process. Construction is expected to begin in early 1977.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for 62%; fuels, 36%; and metals, 2% of the State's total mineral production value in 1976. The principal nonmetals produced, listed in descending order of value, were phosphate rock, stone, cement, clays, and sand and gravel.

Cement.—Portland cement shipments increased 13% from 1975 levels. Portland cement shipments were 1.9 million tons valued at \$67.8 million, an 8% increase in value from that of 1975. Masonry cement shipments decreased 1% while value increased 2% over that of 1975.

Types I and II (general-use and moderate-heat), Type III (high-early-strength), and Type V (high-sulfur-resistant) cements were produced. Most of the shipments of both portland and masonry cements were used within the State.

Portland cement shipments mainly in bulk form were made by truck (88%) and by rail (12%). Principal consumers were ready-mix concrete companies (55%), concrete products manufacturers (20%), building materials dealers (10%), highway contractors (8%), and the remainder for miscellaneous uses.

Raw materials used in the manufacture of cement were mined principally within the State and included limestone, clay, sand, and staurolite. Oolitic aragonite imported from the Bahamas was used exclusively by one company while another used lesser amounts. Small amounts of gypsum and blast furnace slag were obtained from out-of-State sources.

Eleven rotary kilns were operated at five plants. Ten plants used the wet process and one, the dry process. The National Portland Cement Co. plant in Port Manatee

processed imported and domestic clinker for sale in the State. Maule Industries, Inc., also processed imported clinker. Almost 300 million kilowatt-hours of electrical energy were consumed in the manufacture of cement; 100% of the power was purchased.

Florida Mining & Materials Corp. converted its new cement plant near Brooksville from oil to coal.⁷

Clays.—Total clay output decreased almost 5% while the value increased 21%.

Florida fuller's earth production ranked first in the Nation. Fuller's earth output increased 7% and the value increased 20%. Two producers were active in Gadsden County and one producer in Marion County. The unit value of fuller's earth was \$46.03 per ton. Fuller's earth was used for fertilizer fillers, pet waste absorbents, pesticides, drilling mud, paper coating, and other uses.

Kaolin output increased about 10% and the value increased 21% over that of 1975. The unit value for kaolin was \$42.06 per ton. Kaolin was produced by one company in Putnam County; principal uses were in electrical porcelain, whiteware, and wall tile.

Miscellaneous clay output decreased about 21% but the value increased 38% above that of 1975. The unit value for miscellaneous clay was \$2.60 per ton. Clays used in the manufacture of cement contributed to the decline in output, while the clay used in the manufacture of lightweight aggregate remained the same. The clays were used primarily for the manufacture of cement and lightweight aggregate. No commercial brick was manufactured in the State during 1976. The one producer in Escambia County closed down because of

⁷ The Tampa Tribune. Oct. 27, 1976.

natural gas curtailments to its kilns. Other clay mines were operated in Clay and Hernando Counties in 1976.

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 silica fluoride, and for water fluoridation. The value of fluorine byproducts is not included in the State's mineral production value.

Gypsum.—Imported crude gypsum was calcined by three companies for use in the manufacture of gypsum building products. United States Gypsum Co. and Celotex Corp. operated plants near Jacksonville, Duval County; and National Gypsum Co. operated a plant near Tampa, Hillsborough County. The three plants used calcining kettles, one rotary kiln, and one holoflote in processing gypsum and manufacturing of gypsum products. A total of 378,000 short tons of calcined gypsum was produced, an increase of 10% over that of 1975.

Lime.—Basic Magnesia, Inc., in Gulf County; Chemical Lime, Inc., in Hernando County; and Dixie Lime & Stone Co. in Sumter County produced 179,000 tons of lime valued at \$8 million for magnesia, water treatment, sewage disposal, and other uses. Output was 10% below that of 1975. The lime was all used in Florida.

Magnesia.—Basic Magnesia, Inc., Port St. Joe, Gulf County, produced caustic calcined magnesia and refractory-grade magnesia from seawater. Shipments and value increased 10% and 19%, respectively, over that of 1975.

Perlite.—Four companies produced expanded perlite from crude ore shipped into the State. The quantity sold or used increased to 23,611 short tons from 21,344 short tons in 1975. The value of the quantity sold or used was \$1,551,927, an increase of 8% over that of 1975. Production from plants in Broward, Duval, Escambia, and Indian River Counties was used for horticultural uses, construction, formed products, and insulation uses. The value of expanded perlite is not included in the State's mineral value.

Phosphate Rock.—Marketable production of phosphate rock increased 2% in quantity, but the value declined 17%, reflecting a price softening trend that began in 1975.

Florida's 1976 production data are combined with that of North Carolina to conceal the latter's output because there is only one producing company in North Carolina. Marketable production sold or used totaled 37.4 million tons valued at \$775.1 million, a 1% decrease from the 38 million tons in 1975. Agricultural uses accounted for 73%; industrial uses, 1%; and exports, 26%. Exports from the two States were valued at \$255 million. Agricultural uses were for normal superphosphate, triple superphosphate, wet-process phosphoric acid, direct application to the soil, and defluorinated phosphate rock. Industrial uses included the manufacture of elemental phosphorus.

Mine production of crude dry ore in Florida and North Carolina was 158 million tons with a P_2O_5 content of 17.3 million tons.

Land-pebble phosphate was produced at 20 mines by 11 companies in 3 counties. Two companies processed tailings from old wastes.

Soft-rock phosphate was produced by four companies operating six mines in two counties. Total mine production was 29,320 tons with a P_2O_5 content of 5,971 tons, valued at \$542,000. The soft-rock phosphate was used for direct application to the soil.

Marketable phosphate rock was produced from Florida land-pebble phosphate mines by Agric Chemical Co.; Borden, Inc.; Brewster Phosphates; Florida Agglite Corp.; Gardinier, Inc.; W. R. Grace & Co.; International Minerals & Chemical Corp. (IMC); Mobil Oil Corp.; Poseidon Mines, Inc.; Occidental Petroleum Corp.; Swift Chemical Co.; T. A. Minerals Corp.; and U.S.S. Agri-Chemicals, Inc.

Agrico Chemical Co.'s Fort Green mine went on-stream in midyear and, after completing its shakedown, operated at design capacity. Agrico announced it had agreed to acquire 40% of Compagnie Francaise del 'Azote (COFAZ), France's second largest fertilizer company, along with a 40% stake in a joint phosphate mining venture to be set up in Florida to supply COFAZ. A definitive article on Agrico's Fort Green mine was published.⁸

Beker Industries Corp. received approval from the Manatee County Commissioners

⁸ Pit & Quarry. Agric Chemical Company's New Florida Phosphate Washer. V. 69, No. 2, August 1976.

to apply for building permits for its proposed mining operation in Manatee County. The company continued to follow the critical path for permitting in anticipation of going onstream with its Manatee County mine in 1980.

Borden Chemical division of Borden, Inc., received approval from both the Hillsborough County Commissioners and the Planning Commission to develop its 4,864-acre Big Four mine in southeastern Hillsborough County. Site clearing and construction were underway at midyear. The Big Four mine is planned to produce 1.25 million tons per year of product to be used internally in fertilizer manufacture.

Brewster Phosphates began mining at its Lonesome mine in Hillsborough County. The design capacity of the operation is 2.8 million tons per year and costs over \$75 million. Overburden on the Lonesome property averages 25.5 feet, and matrix, 11.5 feet. The phosphate product is expected to grade about 70% to 71% bone phosphate of lime (BPL).⁹

C. F. Industries Inc. submitted its Development of Regional Impact Study (DRI) to the Central Florida Regional Planning Council to mine its 19,555 acres in Hardee County. The mining plan shows that an average of 574 acres will be mined annually for 25 years producing over 94 million tons of phosphate rock. The initial phase calls for a 2-million-ton-per-year mine and washer. When the mine goes onstream in 1978, a 400,000-ton-per-year phosphoric acid chemical plant will be constructed with plans to go onstream in 1979. The last phase will be to expand the mine from 2 to 4 million tons per year in 1981.¹⁰

First Mississippi Corp. purchased 2,000 acres of phosphate reserve lands in southeastern Hillsborough County. According to the company, the lands contain 7.5 million tons of high-grade phosphate reserve.¹¹

Freeport Chemical Co. announced that it had leased 6,000 acres of phosphate lands in southwestern Hardee County and has options to buy another 7,700 acres in the county. Mining of these deposits is estimated to begin in 1981.¹²

Farmland Industries purchased 721 acres of phosphate reserve lands in De Soto County. No immediate development plans were announced.¹³

W. R. Grace & Co. announced that it has holdings of almost 80,000 acres in central

Florida with 80 years of phosphate reserves which include both primary and secondary deposits. The company continued its plans for development of its Four Corners mine and continued to develop data for the required permits.¹⁴

Gardiner, Inc., purchased 178 acres in fee and another 135 acres of mineral rights adjacent to its lands in Hardee County.

IMC announced plans to construct a \$36 million animal feed ingredients plant adjacent to its New Wales complex. The new plant will have a production capacity of 435,000 tons per year. Construction is expected to begin in late 1977.¹⁵

IMC also has taken an option on 21,000 acres in Brevard County known as the Deseret Ranches, Inc. A company spokesman stated that any operations in this area would be 10 to 15 years away and would follow other anticipated Florida operations now underway.¹⁶

Mississippi Chemical Co. purchased or has options on 20,000 acres in western Hardee County and reiterated its intentions to mine in 1980. Plans call for permit applications in 1976. Detailed engineering is to be completed in 1977 and construction of the washer-beneficiation plant is to begin in 1978. The phosphate rock products will be shipped to Mississippi to be converted into fertilizer.¹⁷

Noranda Phosphate, Inc., purchased 320 acres of phosphate reserve land in Hardee County expanding its holdings to about 10,000 acres.¹⁸

Occidental Chemical Co. (Oxy) signed the first chemical purchase contract under its long-term fertilizer agreement with the U.S.S.R. The contract calls for Oxy to buy an average of 350,000 tons per year of ammonia for a 10-year period beginning in 1978. In addition, Oxy will sell 1 million tons per year of superphosphoric acid to the U.S.S.R. and buy back 1.5 million tons per year of ammonia, an equal amount

⁹ Engineering and Mining Journal. *Phosphates Are Vital to Agriculture—and Florida Mines for One-Third the World*. V. 177, No. 5, May 1976, p. 85.

¹⁰ The Wachula Herald-Advocate. July 8, 1976.

¹¹ Sarasota Herald-Tribune. July 23, 1976.

¹² The Lakeland Ledger. Nov. 26, 1976.

¹³ Arcadian. Feb. 5, 1976.

¹⁴ The Lakeland Ledger. Oct. 15, 1976.

¹⁵ The Tampa Tribune. Nov. 5, 1976.

¹⁶ The Tampa Tribune. Oct. 26, 1976.

¹⁷ Wachula Herald-Advocate. Jan. 15, 1976.

¹⁸ Wachula Herald-Advocate. July 8, 1976.

of urea, and 1 million tons per year of potash.¹⁹

The Jacksonville Port Authority agreed to issue up to \$50 million in tax-free bonds to Hooker Chemical Co. to build loading facilities in the port of Jacksonville with capacities of 90,000 tons of superphosphoric acid, 40,000 tons of dry fertilizer, plus facilities of 30,000 tons capacity for storing Soviet ammonia.²⁰

Phillips Petroleum Co.'s development of a regional impact statement to mine phosphate in De Soto and Manatee Counties was approved by the county commissioners of both counties. The company continued the critical path for permitting in anticipation of developing its Manatee-De Soto properties in 1978.

Swift Chemical Co.'s plans for developing its Manatee County properties will be delayed because of Manatee County's moratorium on processing mining applications.²¹

T&A Minerals Corp.'s Polk County facilities came onstream during the year. The plant is designed to produce one-half million tons of phosphate rock annually. T&A is operating two mines: One which processes debris, mining it with a 14-inch by 12-inch cutterhead dredge; the second operation mines virgin land using conventional Florida phosphate mining practices. The processing plant has been designed to be flexible in processing ores from the adjacent property or ores shipped to the plant by truck from the Citrus County mine.

Several articles were published describing

technical advances and innovations in the central Florida phosphate areas.²²

Sand and Gravel.—Sand and gravel output totaled 13 million tons valued at \$19 million. Production and value decreased 2% and 5%, respectively, from that of 1975. These slight decreases in sand and gravel output in 1976 indicate a stabilization in the construction industry in Florida and along with other indicators, reflect the beginning of a more stable economy.

Lake, Polk, and Broward Counties were the leading producing counties accounting for 47% of the output. Polk, Broward, and Lake Counties led in the value of sand produced and accounted for 41% of the value.

During the year, 50 companies operated 63 mines in 24 counties. Nearly all the sand produced was by commercial operators. Of the 63 sand and gravel operations, 7 produced between 500,000 and 1,000,000 tons, 24 produced between 100,000 and 500,000 tons, and 32 produced less than 100,000 tons. Virtually all of the sand and gravel was transported by truck with minor amounts by rail and water. The sand and gravel was mainly used for construction purposes with a small amount going into industrial uses.

¹⁹ Chemical Week, Dec. 1, 1976.

²⁰ Sarasota Herald-Tribune, July 30, 1976.

²¹ The Bradenton Herald, May 5, 1976.

²² Engineering and Mining Journal, V. 177, No. 3, March 1976.

———, Phosphates Are Vital to Agriculture—and Florida Mines for One-Third the World, V. 177, No. 5, May 1976, pp. 79-89.

———, V. 177, No. 3, September 1976.

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

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	10,829	\$12,958	\$1.25
Gravel	2,555	4,792	1.85
Total	12,914	17,750	1.37
Industrial sand	290	1,414	4.88
Grand total	13,204	19,164	1.45

Table 5.—Florida: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	4,355	\$6,210	\$1.43
Concrete products (cement blocks, bricks, pipe, etc.)	3,686	5,398	1.46
Asphaltic concrete aggregates and other bituminous mixtures	674	1,355	2.01
Roadbase and coverings	1,698	2,498	1.47
Fill	2,342	2,084	.89
Other uses	158	205	1.30
Total	¹ 12,914	17,750	1.37

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

Staurolite.—Staurolite was recovered as a byproduct of ilmenite production at the Highland and Trail Ridge plants of E. I. du Pont de Nemours & Co., in Clay County. Production and value increased. Staurolite was mainly used in sandblasting with minor amounts for cement. Florida is the only State with a recorded production of staurolite.

Stone.—Florida stone (all limestone) is divided into two types—hard rock and soft rock. Each type has a different end use and value. Hard rock is used as concrete, bituminous and macadam aggregates, and ranges in value from \$1.50 to \$3.99 per ton. Soft rock limestone is used as dense-graded roadbase material, surface treatment aggregate, and in the manufacture of lime; it ranges in value from \$0.80 to over \$2.00 per ton.

Crushed limestone output was 38.0 million tons valued at \$73.3 million, a decrease of 1% in tonnage while the value increased 1% above that of 1975. These statistics indicate a stabilizing of the construction activity in the State. Output came from 65 companies operating 122 quarries in 24 counties compared with 69 companies operating 119 quarries in 21 counties in 1975. The three leading producing counties were Dade, Hernando, and Broward, which supplied 68% of the State's total tonnage and 67% of the value. Eight companies produced over 1 million tons from 18 quarries and accounted for over 50% of the crushed stone output and 65% of the value. Of the total crushed limestone sold or used, agricultural stone accounted for 3% of the quantity and 5% of the value; concrete aggregate, 30% and 35%, respectively; bituminous aggregate, 7% and 7%, respectively;

and dense-graded roadbase, 36% and 27%, respectively. Four companies processed oyster shells for roadbase material.

The American Stone Co. quarried dimension limestone in Manatee County for cut stone, rough construction, and dressed flagging.

Sulfur.—Recovered sulfur from petroleum production at Exxon's desulfurization plants in Santa Rosa and Escambia Counties increased from 284,833 long tons in 1975 to 306,721 long tons in 1976. The value of byproduct sulfur is not included in the State's mineral production value.

Vermiculite.—Exfoliated vermiculite was produced by two operators at four plants in Broward, Duval, and Hillsborough Counties from crude ore shipped into the State. The exfoliated vermiculite was used for lightweight concrete aggregate, plaster aggregate, insulation, and other uses. The value of vermiculite is not included in the State's mineral value.

METALS

Metals accounted for only 2% of the State's total mineral production value.

Rare-Earth Minerals.—Humphrey's Mining Co., Nassau County, and Titanium Enterprises, Clay County, produced monazite concentrate as a coproduct from their heavy mineral operations. Output and value decreased from that of 1975.

Titanium Concentrate.—E. I. du Pont de Nemours & Co., and Titanium Enterprises produced ilmenite and rutile concentrates from their plants in Clay County and Humphrey's Mining Co. produced ilmenite concentrate from its mine in Nassau County. Overall production and value increased.

Zircon Concentrate.—Production of zircon concentrate from E. I. du Pont de Nemours & Co.'s Trail Ridge plant and Titanium Enterprises' Green Cove Springs plant, both in Clay County, decreased 7% in quantity and 21% in value from that of 1975.

MINERAL FUELS

Mineral fuels produced were natural gas, natural gas liquids, crude petroleum, and peat.

Natural Gas.—Total marketed production of natural gas in Florida in 1976 was about 43.2 billion cubic feet. The difference between the marketed volume and the 46.5 billion cubic feet measured at the wellhead was due to a 12.3% content of H₂S, CO₂, and N₂, plus plant losses and in-plant consumption for fuel. All of the gas sold was from the Blackjack Creek and Jay fields, except a small quantity that was produced from the nearby Mount Carmel field. Gas production at the Jay field currently exceeds 100 million cubic feet per day, and more than 300 billion cubic feet are expected to be produced during the lifetime of the field. Production of butane, propane, and ethane began at Jay in 1975 when a new gas liquids plant began operation. The facility strips approximately 20,000 barrels of gas liquids per day from the natural gas produced in the field.

The Five Flags Pipeline Co. sold natural gas and ethane produced therefrom to industrial customers in the Pensacola area. Commercial and residential customers purchased the remaining methane from the Florida Gas Co.

Prior to distribution to the Florida Gas Transmission Pipeline Co., a subsidiary of Florida Gas Co., the gas was stripped of natural gas liquids at a plant in Jay field, northern Santa Rosa County. The Btu value of the gas was reduced from 1,450 to 1,040 Btu per cubic foot before distribution through the interstate pipeline of Florida Gas Co.

Peat.—Peat production decreased from 82,000 tons in 1975 to 78,800 tons in 1976 while the value increased from \$1,037,000 in 1975 to \$1,287,000 in 1976, representing

a 4% decrease in quantity and a 24% increase in value. Twelve companies produced moss, reed-sedge, and humus peat. Shipments totaled 78,800 tons and consisted of 92% moss, 7% reedsedge, and 1% humus. Most of the peat was shipped in bulk and used to pack flowers, plants, and shrubs; for general soil improvement; and in potting soils.

Petroleum.—Total oil production in Florida was 44.5 million barrels in 1976. The 6% increase was primarily attributed to increased production in the Jay and Blackjack Creek fields. Jay field yielded 25% of the total crude oil production in the State. The wellhead value of northwestern Florida crude oil and associated gas averaged \$12.30 per barrel in January 1976.²⁸

Petroleum production in the Jay field is now over 90,000 barrels of oil per day. The Jay field is expected to produce an estimated 345 million barrels of oil before it is depleted in the 1990's.

South of Jay, the Blackjack Creek field is now producing 15,000 barrels of oil per day. The field began production in January 1975. A new waterflood plant began operation in the Blackjack Creek field in 1976. The plant injects more than 25,000 barrels of water into the underground oil reservoir per day to help maintain pressure and increase the ultimate recovery of oil to approximately 40 million barrels, about twice the amount which would be possible without the secondary recovery program.

Crude petroleum production from south Florida was derived entirely from the Lower Cretaceous Age Sunniland Limestone Formation. The average depth of a development well in the Sunniland trend is about 11,500 feet. There are 74 producing wells in 8 fields in this trend.

Approximately 4.85 million barrels of crude oil ranging from 25° API to 32° API gravity, representing 10.9% of Florida's total production, were produced from south Florida fields. Wellhead prices ranged from \$5.15 per barrel in January to \$11.40 per barrel in December 1976 for old and new oil combined.

²⁸ Based on 5% gross production tax reported to Florida Department of Revenue.

Table 6.—Florida: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Collier	3	--	2	--	--	4	9	99,967
De Soto	--	--	--	--	--	1	1	11,662
Escambia	1	--	--	--	--	1	2	16,211
Franklin	--	--	--	--	--	1	1	11,950
Gulf	--	--	--	--	--	1	1	13,606
Hendry	2	--	--	--	--	--	2	23,182
Lee	4	--	2	--	--	1	7	82,505
Santa Rosa	1	--	1	--	--	3	5	79,273
Walton	--	--	--	--	--	2	2	4,894
Total	11	--	5	--	--	14	30	343,255

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Florida Mining & Materials Corp.	Box 23965 Tampa, Fla. 33622	Plant	Hernando.
General Portland, Inc	4400 Republic National Bank Tower, Box 324 Dallas, Tex. 75221	Plants	Dade and Hills- borough.
Maule Industries, Inc	Box 2035 PVS Hialeah, Fla. 33012	Plant	Dade.
Southeastern Materials, Inc.	Box 2634 Hialeah, Fla. 33012	do	Do.
Clays:			
Engelhard Minerals & Chemicals Corp.	Menlo Park Edison, N.J. 08817	Open pit mines	Gadsden.
Mid-Florida Mining	Box 68-F Lowell, Fla. 32663	do	Marion.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W. Va. 25411	do	Gadsden.
Gypsum (calcined):			
Celotex Corp	1500 North Dale Mabry Tampa, Fla. 33607	Plant	Duval.
National Gypsum Co	325 Delaware Ave. Buffalo, N.Y. 14202	do	Hillsborough.
United States Gypsum Co	101 South Wacker Dr. Chicago, Ill. 60606	do	Duval.
Lime:			
Chemical Lime, Inc	Box 250 Ocala, Fla. 32670	do	Hernando.
Dixie Lime & Stone Co. ¹	Drawer 217 Ocala, Fla. 32670	do	Sumter.
Magnesium compounds:			
Basic Magnesia, Inc. ²	Box 160 Port St. Joe, Fla. 32456	do	Gulf.
Peat:			
Delta Peat	Box 155 Mango, Fla. 33550	Bog	Hillsborough.
Oxford Peat Co	Box 154 Oxford, Fla. 32684	Bog	Sumter.
Superior Peat & Soil	Box 1688 Sebring, Fla. 33870	Bog	Highlands.
Perlite (expanded):			
Airlite Processing Corp. of Florida.	Route 2, Box 740 Vero Beach, Fla. 32960	Plant	Indian River.
Armstrong Cork Co	Box 1991 Pensacola, Fla. 32589	do	Escambia.
Chemrock Corp	End of Osage St. Nashville, Tenn. 37208	do	Duval.
W. R. Grace & Co. ³	62 Whittemore Ave. Cambridge, Mass. 02140	do	Broward.
Petroleum (crude):			
Exxon Co., U.S.A	Box 2024 Houston, Tex. 77001	Wells	Santa Rosa.
Sun Oil Co	Box 2880 Dallas, Tex. 75221	do	Collier and Hendry.

See footnotes at end of table.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Petroleum (refined): Seminole Asphalt Refining, Inc.	Box 128 St. Marks, Fla. 32355	Refinery -----	Wakulla.
Phosphate rock:			
Agrico Chemical Co -----	Box 3166 Tulsa, Okla. 74101	Open pit mines and plants.	Polk.
Borden, Inc -----	Box 790 Plant City, Fla. 33566	Open pit mine and plant.	Do.
Brewster Phosphates -----	Bradley, Fla. 33835	-----do -----	Do.
Gardinier, Inc -----	Box 3289 Tampa, Fla. 33601	-----do -----	Do.
International Minerals & Chemical Corp.	Box 867 Bartow, Fla. 33830	Open pit mines ---	Do.
Mobil Oil Corp. ⁴ -----	Box 311 Nichols, Fla. 33863	-----do -----	Do.
Occidental Petroleum Corp.	White Springs, Fla. 32096	Open pit mine ---	Hamilton.
Swift Chemical Co -----	Box 208 Bartow, Fla. 33830	Open pit mines ---	Polk.
U.S.S. Agri-Chemicals, Inc.	Box 867 Fort Meade, Fla. 33841	Open pit mine ---	Do.
W. R. Grace & Co -----	Box 471 Bartow, Fla. 33830	Open pit mine and plant.	Do.
Sand and gravel:			
Florida Rock Industries, Inc.	Box 4667 Jacksonville, Fla. 32201	Pits -----	Clay, Dade, Glades, Lake.
E. R. Jahna Industries, Inc.	First & East Tillman Lake Wales, Fla. 33853	-----do -----	Lake and Polk.
Ortona Sand Co -----	First & East Tillman Lake Wales, Fla. 33853	Dredge -----	Hendry.
L. W. Rozzo, Inc -----	4435 SW. 26th St. Fort Lauderdale, Fla. 33314	Pit -----	Broward.
Warren Bros. Co -----	Fairfield, Maine 04937	Pit -----	Sarasota.
Staurolite:			
E. I. du Pont de Nemours & Co. ⁵	DuPont Bldg. D-10084 Wilmington, Del. 19898	Plant -----	Clay.
Stone:			
Florida Crushed Stone Co--	Box 668 Ocala, Fla. 32670	Quarries -----	Hernando and Sumter.
Florida Mining and Materials Corp.	Box 59351 Miami, Fla. 33159	Quarry -----	Hernando.
Florida Rock Industries, Inc. ⁶	Box 4667 Jacksonville, Fla. 32201	Quarries -----	Collier, Lee, Sumter, Suwannee.
Maule Industries, Inc -----	Box 2601 Hialeah, Fla. 33012	-----do -----	Dade.
Southeastern Materials, Inc.	Box 2634 Hialeah, Fla. 33012	-----do -----	Do.
Titanium concentrate:			
Titanium Enterprises ⁷ ----	Green Cove Springs, Fla. 32043	Mine and plant ---	Clay.

¹ Also stone.² Also lime.³ Also phosphate rock and exfoliated vermiculite.⁴ Also elemental phosphorus.⁵ Also titanium and zircon concentrates.⁶ Also sand and gravel.⁷ Also zircon concentrate and rare-earth oxides and thorium oxide in monazite concentrate.

The Mineral Industry of Georgia

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Georgia Department of Natural Resources, Geologic and Water Resources Division, under a cooperative agreement for collecting information on all minerals except fuels.

By Doss H. White, Jr.¹ and Sam M. Pickering, Jr.²

As the United States celebrated the Bicentennial, Georgia's mineral industry was well into its quadricentennial period; records indicate that a Spanish mission built partly of brick made from local material was located on one of the State's coastal islands sometime between 1530 and 1560. From this meager beginning, the State's mineral production had risen to a record high of \$428 million in 1976.

Nonmetallic industrial minerals comprised the major portion of Georgia's mineral production. Clays, were again the lead-

ing mineral commodity in the State in terms of value, accounting for 64% of the total mineral production value. In 1976, Georgia ranked first in clay production; however, metal processing and fabricating industries, including two of the Nation's largest facilities for producing electrical and communications cable and wire, are located in the State.

¹ State Liaison Officer, Bureau of Mines, Atlanta, Ga.

² State geologist and director, Geologic and Water Resources Division, Georgia Department of Natural Resources.

Table 1.—Mineral production in Georgia¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland ----- thousand short tons...	828	\$25,822	930	\$30,085
Clays ----- do....	6,156	195,300	7,471	273,145
Coal, bituminous ----- do....	W	W	186	6,152
Peat ----- do....	(²)	5	W	W
Sand and gravel ----- do....	5,105	8,818	4,855	8,387
Stone ----- do....	30,084	91,157	31,855	98,806
Talc ----- short tons...	27,400	82	W	W
Value of items that cannot be disclosed:				
Barite, bauxite, cement (masonry), feldspar, iron ore, kyanite, mica (scrap), and values indicated by symbol W	XX	12,203	XX	11,904
Total	XX	333,387	XX	428,479
Total 1967 constant dollars	XX	131,921	XX	154,038

^P Preliminary. W Withheld to avoid disclosing company proprietary data; value included with "Value of items that cannot be disclosed." 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 mineral production in Georgia, by county ¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Bacon	W	W	Sand and gravel.
Baldwin	\$84	W	Do.
Banks	73	W	Stone.
Barrow	189	\$44	Do.
Barrow	189	\$44	Do.
Bartow	4,375	W	Barite, stone, clays.
Bibb	W	W	Clays, sand and gravel.
Burke	W	W	Do.
Carroll	W	W	Stone.
Chatham	294	287	Sand and gravel.
Chattooga	W	W	Coal.
Cherokee	W	W	Mica.
Clarke	1,864	W	Stone.
Clayton	W	W	Do.
Cobb	W	W	Stone, sand and gravel.
Coffee	W	W	Sand and gravel.
Columbia	W	W	Clays.
Columbus (city)	W	W	Stone, sand and gravel, clays.
Cook	W	W	Sand and gravel.
Coweta	W	W	Stone.
Crawford	W	W	Sand and gravel.
Dade	W	W	Coal.
Dawson	49	W	Clays, sand and gravel.
Decatur	W	W	Stone.
De Kalb	5,112	4,963	Stone.
Dougherty	279	174	Sand and gravel.
Douglas	W	W	Stone, clays, sand and gravel.
Early	W	W	Do.
Effingham	639	W	Stone, sand and gravel.
Elbert	W	W	Do.
Evans	159	W	Sand and gravel.
Fannin	12	W	Do.
Fayette	844	1,004	Stone.
Floyd	W	W	Stone, clays.
Forsyth	W	W	Stone, sand and gravel.
Fulton	W	W	Cement, stone, clays, sand and gravel.
Gilmer	W	W	Stone.
Glynn	W	W	Sand and gravel.
Gordon	568	W	Stone.
Greene	W	W	Stone, sand and gravel.
Gwinnett	W	W	Stone.
Habersham	W	W	Do.
Hall	W	W	Do.
Hancock	W	W	Mica.
Hart	W	W	Stone.
Henry	W	W	Cement, stone, clays.
Houston	W	W	Feldspar, stone.
Jasper	W	W	Clays.
Jefferson	W	W	Stone.
Jones	W	W	Do.
Laurens	W	W	Sand and gravel.
Lee	W	W	Kyanite.
Lincoln	W	W	Sand and gravel.
Lowndes	W	W	Stone.
Lumpkin	W	W	Do.
Madison	W	W	Sand and gravel.
Marion	W	W	Peat.
Miller	2	W	Stone.
Mitchell	357	78	Do.
Monroe	W	W	Talc.
Murray	W	W	Stone.
Oglethorpe	2,001	1,997	Do.
Paulding	W	W	Do.
Pickens	9,657	12,340	Do.
Pierce	W	W	Sand and gravel.
Pike	168	W	Do.
Polk	W	W	Cement, stone, clays.
Quitman	W	W	Iron ore.
Rabun	W	W	Stone.
Richmond	W	W	Clays, stone, sand and gravel.
Screven	3	W	Do.
Seminole	W	W	Sand and gravel.
Spalding	W	W	Stone.
Stephens	W	W	Do.
Stewart	W	W	Iron ore.
Sumter	W	W	Clays, bauxite.
Talbot	549	447	Sand and gravel.
Taylor	679	729	Do.

See footnotes at end of table.

Table 2.—Value of mineral production in Georgia, by county ¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Telfair -----	W	--	
Thomas -----	W	W	Clays, sand and gravel.
Tift -----	W	W	Sand and gravel.
Troup -----	W	W	Stone.
Twiggs -----	\$51,368	\$63,150	Clays.
Union -----	W	W	Stone, sand and gravel.
Upson -----	W	W	Sand and gravel.
Walker -----	W	W	Stone, coal, clays.
Walton -----	W	W	Stone.
Ware -----	W	W	Sand and gravel.
Warren -----	W	24,915	Clays, stone.
Washington -----	57,308	77,078	Clays.
Wheeler -----	W	W	Sand and gravel.
Whitfield -----	W	W	Stone.
Wilkinson -----	29,950	39,601	Clays.
Undistributed ² -----	167,302	201,639	
Total ³ -----	333,387	428,479	

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

¹ The following counties are not listed because no production was reported: Appling, Atkinson, Baker, Ben Hill, Berrien, Bleckley, Brantley, Brooks, Bryan, Bulloch, Butts, Calhoun, Camden, Candler, Catoosa, Charlton, Chattahoochee, Clay, Clinch, Colquitt, Crisp, Dodge, Dooly, Echols, Emanuel, Franklin, Glascock, Grady, Haralson, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lamar, Lanier, Liberty, Long, McDuffie, McIntosh, Macon, Meriwether, Montgomery, Morgan, Muscogee, Newton, Oconee, Peach, Pulaski, Putnam, Randolph, Rockdale, Schley, Taliaferro, Tattnall, Terrell, Toombs, Towns, Treutlen, Turner, Wayne, Webster, White, Wilcox, Wilkes, and Worth.

² Includes values indicated by symbol W.

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

Table 3.—Indicators of Georgia business activity

	1975	1976 ¹	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	2,143.0	2,206.0	+2.9
Unemployment -----do-----	185.0	179.0	-3.2
Employment (nonagricultural):			
Mining -----do-----	6.9	6.9	--
Manufacturing -----do-----	439.3	477.2	+8.6
Contract construction -----do-----	87.5	84.2	-3.8
Transportation and public utilities -----do-----	113.4	117.2	+3.4
Wholesale and retail trade -----do-----	396.3	419.4	+5.8
Finance, insurance, real estate -----do-----	97.3	98.8	+1.5
Services -----do-----	260.0	276.7	+6.4
Government -----do-----	354.3	364.1	+2.6
Total nonagricultural employment -----do-----	¹ 1,755.7	¹ 1,844.4	+5.1
Personal income:			
Total -----millions--	\$24,734	\$27,576	+11.5
Per capita -----do-----	\$5,016	\$5,548	+10.6
Construction activity:			
Number of private and public residential units authorized -----do-----	21,009	24,489	+16.6
Value of nonresidential construction -----millions--	\$349.5	\$346.0	-1.0
Value of State road contract awards -----do-----	\$208.5	\$215.0	+3.1
Shipments of portland and masonry cement to and within the State -----thousand short tons--	1,685	1,780	+5.6
Mineral production value:			
Total crude mineral value -----millions--	\$333.4	\$428.5	+28.5
Value per capita, resident population -----do-----	\$68	\$86	+26.5
Value per square mile -----do-----	\$5,663	\$7,278	+28.5

¹ Preliminary.

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.

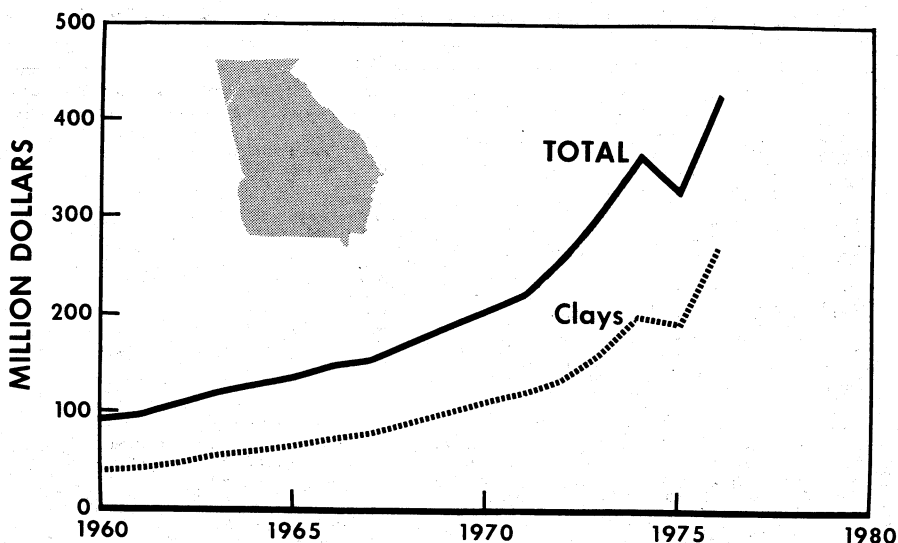


Figure 1.—Value of clays, and total value of mineral production in Georgia.

During the year, the Georgia Division of Geology and Water Resources continued its program of geologic mapping and minerals data acquisition. At yearend, the Division staff consisted of 27 professionals and 7 support personnel. One highlight of the year was the publication of a new State geological map on a 1:500,000 scale. Also published during the year was a physiographic map of the State on a 1:2,000,000 scale. The Division initiated a new educational series with the publication of "Georgia, A View From Space; An Interpretation of Landsat-1 Imagery."

Geologists assigned to the Southeastern Office of Bendix Corp., a subcontractor of the Energy Research and Development Ad-

ministration, conducted studies in northeast Georgia along the War Woman Sheer to help determine the relationship of faulting to uranium deposition. Bendix geologists also conducted a ground-truth followup survey of an aeroradiometric survey flown over the northeastern part of the State.

The Bureau of Mines Metallurgy Engineering Laboratory in Boulder City, Nev., continued work on extracting alumina from Georgia kaolin. Work was concentrated on the hydrochloric acid leaching miniplant experiment. Work was also underway at the Bureau of Mines Metallurgy Research Station in Tuscaloosa, Ala., to determine useful properties of silica wastes generated by the Georgia kaolin-alumina research.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Barite.—The State's barite production is centered in the Cartersville district in northwest Georgia. Barite was first mined in 1901 and total production has been reported at approximately 5.5 million tons valued at over \$60 million. While 23 different companies have produced barite from the district, only 2, New Riverside Ochre Co. and Paga Mining Co., were active in 1976.

New Riverside Ochre Co. barite production is from an open pit operation located within the city limits of Cartersville. Ore is trucked to the company mill south of the city near the Etowah River where gravity and flotation methods are used for concentration. Paga Mining Co., a division of Cyprus Industrial Minerals Co., recovered barite by flotation of wastes discarded by past milling operations in the district.

The barite concentrates were used in the manufacture of barium chemicals, as fillers

and extenders in paint and rubber products, as a weighting medium in drilling muds, glassmaking, flux, and heavy products. Production and value increased for the first time in several years.

Cement.—Three companies, Marquette Cement Manufacturing Co., Martin-Marietta Corp., and Medusa Cement Co., produced portland and masonry cement from plants located in Polk, Fulton, and Houston Counties. Over 50% of the finished portland cement was sold to ready-mix concrete companies with the remainder used by building materials dealers and concrete product, highway, and other contractors and manufacturers.

Production and value of both cement types increased over those reported for 1975 but were still below the 1974 production and value.

Clays.—Historically, Georgia has led the Nation in the production of clay; this was true again in 1976 when the State's clay industry produced 7.5 million tons valued at \$273 million. This is an increase of approximately 1.3 million tons and \$78 million over that reported in 1975. Clays mined in the State, in order of decreasing value, were: kaolin, fuller's earth, common clay, and fire clay.

Kaolin or "china clay" is a white clay or clay-like material which has important industrial applications in paper manufacture and as a filler and carrier. Processing steps are dependent on the proposed end use; however, two basically different processes, dry and wet, are used to produce a salable kaolin product. In the dry process, which produces a lower cost and quality product, the kaolin is crushed, dried, pulverized, and airfloated to remove coarse particles and is used as paper filler, ceramics, in fiberglass, as a filler in adhesives and rubber, and as an insecticide carrier. In the wet process, the kaolin in a slurry is fractionated by use of centrifuges or hydroseparators. The resulting coarse fraction has many uses in common with dry processed kaolin. The fine fraction, after bleaching and dewatering, is used in coating paper, inks, high gloss paints, special ceramics applications such as whitewares and refractories, rubber, and other commercial applications.

During 1976, 21 companies operated in a 7 county area in the Fall Line kaolin belt in east-central Georgia. Those companies produced 4.9 million tons of kaolin valued at \$251 million. Eighty percent of the kaolin was wet processed, 15% was dry processed, and 5% was unprocessed.

At yearend, work was underway at Thiele Kaolin Co. to double the capacity of the firm's 60,000-ton-per-year airfloat plant at Reedy Creek. The plant produces paper filler in both dry form and slurry.

Georgia Kaolin Co. was installing a second 84-inch magnetic separator as a supplement to the unit on-stream at its Sandersville facility, while Engelhard Minerals & Chemicals Corp., at McIntyre expanded calciner capacity and the capacity for fluid bed catalyst.

During the year, Freeport Kaolin Co. completed a 24-mile, 10-inch-diameter, high-pressure pipeline between its processing plant at Gordon and the new Scott mining complex near Sandersville. The new mine complex has a capability of 500,000 tons per year. Cost of the mine was reported to be approximately \$13 million.

Over 500,000 tons of fuller's earth valued at \$17.9 million was produced by seven companies operating in a four-county area. Fuller's earth is a nonplastic clay with a low-bulk density which, after calcining, is used as an oil and gas absorbent on floors in industrial plants, in pet litter boxes to absorb animal wastes, and as a carrier for herbicides and insecticides.

After mining, the fuller's earth is dried, crushed, extruded (extrusion step depends on the end product), kiln dried, ground, classified, and packaged. In 1976, Georgia again led the Nation in fuller's earth production.

Common clay and shale were produced by 14 companies mining in 9 counties with a combined output totaling slightly more than 2 million tons valued at \$4.3 million. These raw materials were used in the manufacture of common brick, sewer pipe, and tile, and other construction materials. Processing usually is restricted to drying, crushing, and firing, depending on the end use.

One company with pits in two counties reported the production of fire clay used in the manufacture of fire brick and flue linings.

Table 4.—Georgia: Kaolin sold or used by producers, by kind and use
(Short tons)

Use	1975			1976			Total	Water-washed ¹	Total
	Airfloat	Unprocessed	Water-washed ¹	Airfloat	Unprocessed	Water-washed ¹			
Domestic:									
Adhesives	51,700	--	11,182	46,091	--	10,214	62,882	10,214	56,305
Alum (aluminum sulfate) and other chemicals	W	W	W	52,982	140,426	49,407	229,981	49,407	242,815
Animal feed	W	W	W	W	W	W	4,925	W	7,598
Catalysts (oil refining)	W	W	W	W	W	40,965	54,408	40,965	91,579
Cement, portland	W	W	W	W	W	W	W	W	W
Crockery and other earthenware	31,530	--	1,871	61,602	--	1,670	33,401	1,670	63,272
Electrical porcelain	6,118	--	1,171	2,564	--	1,469	7,284	1,469	4,033
Face brick	W	--	93	W	--	22	88	22	38,533
Fiberglass	81,215	--	70	86,313	--	185	81,285	185	86,313
Firebrick, block and shapes	25,281	12,520	411	4,168	5,760	185	38,212	185	10,113
Floor and wall tile, ceramic	11,475	W	3,319	4,168	5,760	3,359	14,794	3,359	8,359
Flue linings and high-alumina brick	W	W	--	51,100	8,696	24	60,035	8,696	59,796
Foundry sand	859	--	--	861	--	--	859	--	886
Grogs and crudes, refractory	W	--	226,558	W	--	423,770	226,558	423,770	423,770
Ink	W	--	11,332	W	--	W	11,332	W	10,555
Medical, pharmaceutical, cosmetic	292	--	535	502	--	1,567	737	1,567	1,069
Paint	3,800	--	88,208	73,985	--	92,543	92,008	92,543	171,923
Paper	13,614	--	1,423,521	1,423,521	--	1,570,235	1,423,521	1,570,235	1,584,403
Paper, coating	169,211	--	484,701	92,535	--	783,470	603,532	783,470	825,105
Paper, filling	W	--	38,239	4,794	--	54,980	43,569	54,980	59,474
Plastics	3,326	--	W	W	--	W	W	W	W
Rotary	W	--	W	W	--	W	W	W	W
Roofing granules	32,445	--	W	32,445	--	W	32,445	W	32,993
Rubber	79,917	--	8,590	72,489	--	8,861	88,507	8,861	81,350
Sanitary ware	47,287	W	W	40,511	W	W	88,973	W	65,377

Miscellaneous airfloat:
 China-dinnerware; fertilizer; glazes, glass, and enamels; hobby ceramics; kiln furniture; mineral wool and insulation; pesticides and related products; roofing granules (1975); roofing tile; starch (1975); unknown uses
 Miscellaneous unprocessed: Sewer pipe and data indicated by symbol W
 Miscellaneous waterwashed:
 China-dinnerware; gypsum products; mineral oil filtering, clarifying, and decolorizing; refractory mortar and cement; waterproofing and sealing; textiles; wire and cable; agriculture; unknown uses

21,357	--	--	21,357	--	28,672	--	28,672
--	315,147	--	2 82,962	58,744	--	--	2 116,457
76,747	--	33,016	33,016	--	--	99,236	99,236
653,100	327,667	2,370,040	3,355,807	729,985	252,137	3,184,468	4,166,590
Exports:							
Foundry sand	--	W	W	--	--	116,525	116,525
Paint coating	3,400	13,052	13,052	--	--	16,038	16,038
Paper filling	5,690	349,518	352,918	6,730	--	298,465	305,195
Plastics	8,400	114,144	119,734	402	--	230,271	230,673
Refractories	2,015	13,788	13,788	--	--	18,601	18,601
Rubber	--	184,427	142,827	8,400	--	1,279	9,679
Undistributed	--	393	2,408	112	--	40,337	40,449
Total	19,405	3,000	661,120	16,052	4,603	15,887	20,898
Grand total	677,505	330,667	3,008,755	4,016,927	746,037	256,740	3,991,871
W Withheld to avoid disclosing company proprietary data; included with "Undistributed." 1 Includes calcined and delaminated 2 Incomplete total; remainder included in totals for specific uses.							

Table 5.—Georgia: Kaolin sold or used by producers, by county
(Thousand short tons)

County	1975	1976
Sumter -----	W	W
Twiggs -----	1,058	1,129
Warren -----	264	429
Washington -----	1,303	1,578
Wilkinson -----	626	766
Other counties ¹ -----	766	1,023
Total -----	4,017	4,925

W Withheld to avoid disclosing company proprietary data; not included in total.

¹ Includes Floyd (1975), Houston, and Richmond Counties, and data indicated by symbol W.

Table 6.—Georgia: Kaolin sold or used by producers, by use
(Short tons)

Use	1975	1976
Domestic:		
Paper coating -----	1,442,235	1,584,403
Paper filling -----	603,912	826,105
Paint -----	92,008	171,528
Chemicals -----	229,981	242,815
Whiteware -----	33,401	63,272
Rubber -----	88,507	81,350
Firebrick, block and shapes -----	38,212	10,113
Sanitary ware -----	88,973	65,377
Plastics -----	43,585	59,474
Adhesives -----	62,882	56,305
Fiberglass -----	81,285	86,313
Ceramic floor and wall tile -----	14,794	3,359
Other -----	536,032	916,176
Exports -----	661,120	758,058
Total -----	4,016,927	4,924,648

Feldspar.—Weathered pegmatites were mined for the potash feldspar content by open pit methods at the Monticello mine in Jasper County by The Feldspar Corp., a division of Pacific Tin Consolidated Corp. The feldspar was separated from the waste rock by grinding and flotation and shipped to 20 States, Canada, and Mexico for use in ceramic products.

Gem Stones.—One company in Ball Ground, Cherokee County, mined a weathered staurolite schist for mineral specimens. The schist is trucked from the surface mine to an area near Ball Ground where collectors may recover the staurolite. Additional quantities of the crystals were recovered by the mine owner for sale in a rock and mineral business. Quantity and value of the material recovered is company proprietary.

Gypsum.—Calcined gypsum and gypsum products were produced by three firms

from raw gypsum mined in other States. National Gypsum Co., The Flintkote Co., in Chatham County, and the Gypsum Div., Georgia-Pacific Corp. in Glynn County produced wallboard, cement retarder, fillers, and agricultural soil additives. Gypsum production increased in value and quantity over that reported by the three companies in 1975.

Kyanite-Mullite.—C-E Minerals, Inc., a division of Combustion Engineering, Inc., operated a surface mining operation and a flotation plant at Graves Mountain in Lincoln County. The company operated a calcining-shipment plant at Washington where kyanite from the Graves Mountain quartz-kyanite schist deposit was processed to form refractory mullite grog.

Synthetic mullite, a product of sintering mixtures of aluminous and siliceous materials and other aluminous silicate refractory grogs were produced by Mulcoa Div. of C-E

Minerals in two facilities near Andersonville in Sumter County. Much of the grog was exported to European markets.

Lime.—Georgia's 1976 lime requirements were imported from surrounding States. Although the State has abundant resources of high-quality limestone, no firm has initiated a line operation. Lime receipts rose to 195,582 tons, up from the 156,822 tons reported in 1975. Alabama firms remained the leading lime suppliers for Georgia.

Mica.—The mica industry in Georgia consists of two companies with operations in Cherokee and Hart Counties. Jones Mining Co., Inc., has an operation on Polecat Mountain in Cherokee County where a sericite schist is mined by underground methods. Output from this mine is trucked to Cartersville where it is ground by Thompson-Weinman & Co. for use as paint filler. In Hart County, the Franklin Mineral Products Co., Inc., is mining flake mica from a pegmatite. The raw mica is then ground for use as an extender and filler in various products including paint, wallpaper, and rubber products.

Peat.—Humus peat production declined

for the second straight year. Shep Peat Co., in Miller County, mined peat by first trenching the peat deposits to allow adequate drainage, then harrowing the upper layers and after drying, scraping the dried material into stock piles. Production was sold as a potting medium and general soil conditioner.

Perlite.—Perlite, a volcanic rock mined in Western States was expanded by Armstrong Cork Co. at a facility in Bibb County for use in acoustical tile, pipe insulation, and other lightweight insulating materials. Upon heating, perlite expands 4 to 20 times its original volume, and the resulting product, having low-density and low-thermal conductivity properties as well as high-sound absorption, has several industrial and construction applications.

Sand and Gravel.—In 1976, 64 mines in 34 counties produced sand and gravel. Production totaled 4.8 million tons valued at \$8.4 million. After mining, several processing methods including washing, screening, desliming, attrition scrubbing, flotation, drying, and sizing were used to produce high-quality sand fractions for a full range of industrial applications.

Table 7.—Georgia: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	2,518	\$3,624	\$1.44
Concrete products (cement blocks, bricks, pipe, etc.) -----	582	1,319	2.27
Asphaltic concrete aggregates and other bituminous mixtures -----	133	372	2.80
Roadbase and coverings -----	512	527	1.08
Fill -----	732	574	.78
Other uses -----	45	70	1.56
Total ¹ -----	4,520	6,484	1.43

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

Table 8.—Georgia: Sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	4,014	\$5,643	\$1.41
Gravel -----	507	843	1.66
Total ¹ -----	4,520	6,484	1.43
Industrial sand -----	315	1,903	6.04
Grand total -----	4,835	8,387	1.73

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

Stone.—Georgia ranked first among the States in the production of crushed and dimension granite; second in total dimension stone and dimension marble, crushed marble, and crushed slate; and fourth in production of dimension sand stone (quartzite).

Georgia's crushed stone industry experienced its record year in 1974, followed by a slump created by the 1974-75 recession. Although signs of recovery are in evidence, 1976 production was 8 million tons less than that of 1974. Two significant acquisitions occurred during the year: Florida Rock Products acquired the Marquette Cement Manufacturing Co.'s quarry at Cartersville and Dalton Rock Products Co. acquired quarries at Fairmont and Adairsville. The Georgia Crushed Stone Association was preparing a manual on pavement design at yearend.

Crushed stone was produced by 23 companies at 69 quarries for concrete aggregate and other uses. Output increased 6% to 31,630,000 tons valued at \$85,395,000. Leading producers were Vulcan Materials Co., Martin-Marietta Corp., and Ivy Corp.

Dimension stone was produced by 31 companies at 38 quarries for rough monumental stone, dressed monumental stone, rough blocks, flagging, and other uses. The State's dimension granite industry was centered in Elbert County northeast of Atlanta, while the dimension marble and dimension sandstone industries were located in Pickens County north of Atlanta. Output, reported at 224,700 tons valued at \$13.4 million, continued to decline and was 10% less than that of 1975 production. Leading producers were Coggins Granite Industries, Inc., and Georgia Marble Co.

Table 9.—Georgia: Crushed stone¹ sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	6,231	14,740	6,138	14,360
Roadstone -----	3,587	8,001	6,051	14,930
Concrete aggregate -----	6,109	14,470	5,950	15,530
Bituminous aggregate -----	5,959	14,040	5,584	13,660
Railroad ballast -----	2,390	5,569	2,793	6,868
Cement manufacture -----	1,347	2,178	1,231	2,363
Surface treatment aggregate -----	2,020	5,113	795	1,791
Macadam aggregate -----	602	1,336	W	W
Agricultural limestone -----	W	W	197	626
Lightweight aggregate -----	W	W	W	1,659
Mineral food -----	W	W	143	437
Riprap and jetty stone -----	235	514	114	290
Other uses ² -----	1,354	12,850	2,633	12,880
Total ³ -----	29,834	78,812	31,630	85,395

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

¹ Includes granite, limestone, marble, slate, and sandstone.

² Includes stone used for filler, whitening (1975), terrazzo and exposed aggregate, filter stone (1975), building products, asphalt filler (1975), waste material (1975), unspecified uses, and uses indicated by symbol W.

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

Table 10.—Georgia: Dimension stone¹ sold or used by producers, by use

Use	1975			1976		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough, monumental ----	162,700	1,590,000	\$6,486	143,900	1,475,000	\$4,940
Dressed:						
Monumental -----	W	W	W	20,480	221,300	5,550
Rough block -----	30,450	298,200	937	17,940	184,600	563
Irregular-shaped:						
Stone -----	W	W	W	12,440	158,000	275
Rubble -----	10,920	111,700	102	W	W	W
Flagging -----	4,526	53,020	57	2,622	33,590	92
Other uses ² -----	41,070	488,400	4,763	27,300	300,100	1,991
Total ³ -----	249,700	2,546,100	12,345	224,680	2,372,400	\$13,411

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

¹ Includes granite, sandstone, and marble.

² Includes stone used for curbing, dressed construction stone (1975), other rough stone, cut stone, house stone veneer, sawed stone (1976), unspecified uses, and uses indicated by symbol W.

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

Table 11.—Georgia: Crushed granite sold or used by producers, by use

Use	1975			1976		
	Quantity (thousand short tons)	Value (thousands)	Average per ton	Quantity (thousand short tons)	Value (thousands)	Average per ton
Bituminous aggregate -----	5,459	\$13,003	\$2.38	4,961	\$12,274	\$2.47
Concrete aggregate -----	5,137	12,222	2.38	5,459	14,399	2.64
Dense-graded roadbase stone -----	5,422	12,475	2.30	5,466	12,647	2.31
Macadam aggregate -----	602	1,336	2.22	W	W	W
Surface treatment aggregate -----	1,282	3,073	2.40	493	1,073	2.18
Unspecified construction aggregate and roadstone -----	3,082	6,915	2.24	5,521	13,732	2.49
Railroad ballast -----	2,363	5,516	2.33	2,766	6,808	2.46
Riprap and jetty stone -----	221	488	2.21	94	246	2.62
Manufactured fine aggregate -----	212	465	2.19	20	40	2.00
Other uses ¹ -----	293	583	1.99	2,062	5,706	2.77
Total ² -----	24,072	56,077	2.33	26,838	66,930	2.49

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

¹ Includes poultry grit, filter stone, unspecified uses (1976), and items indicated by symbol W.

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

Table 12.—Georgia: Crushed limestone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	500	1,032	W	W
Concrete aggregate -----	635	1,494	W	W
Dense-graded roadbase stone -----	808	2,261	W	W
Riprap and jetty stone -----	14	27	W	W
Surface treatment aggregate -----	738	2,040	W	W
Unspecified construction aggregate and roadstone -----	503	1,069	W	W
Cement manufacture -----	1,323	2,130	1,195	2,313
Other uses ¹ -----	474	2,099	2,899	7,975
Total -----	² 4,996	12,152	4,094	10,293

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

¹ Includes agricultural limestone, railroad ballast, manufactured fine aggregate, terrazzo and exposed aggregate, cement manufacture, other fillers or extenders, waste material (1976), and items indicated by symbol W.

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

Table 13.—Georgia: Dimension granite sold or used by producers, by county

County	1975				1976			
	Number of quarries	Thou- sand cubic feet	Short tons	Value (thou- sands)	Number of quarries	Thou- sand cubic feet	Short tons	Value (thou- sands)
De Kalb -----	3	230	20,803	\$416	W	W	W	W
Elbert -----	13	520	50,736	3,662	12	499	49,090	\$3,718
Oglethorpe -----	15	703	69,991	2,001	15	621	58,803	1,997
Undistributed ¹ -----	3	753	80,801	2,574	5	897	87,795	2,525
Total ² -----	34	2,205	222,330	8,653	32	2,017	195,691	8,241

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

¹ Includes Hancock and Madison Counties in 1975, and De Kalb and Madison Counties in 1976.

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

Table 14.—Georgia: Dimension granite sold or used by producers, by use

Use	1975			1976		
	Quantity (thousand short tons)	Value		Quantity (thousand short tons)	Value	
		Total (thou- sands)	Average per cubic foot		Total (thou- sands)	Average per cubic foot
Rough:						
Architectural -----	298	\$987	\$3.14	185	\$563	\$3.04
Monumental -----	1,590	6,486	4.08	1,475	4,940	3.35
Other rough stone ¹ -----	114	113	.99	117	161	1.38
Dressed:						
Curbing -----	W	W	W	W	W	W
Other dressed stone ² -----	203	1,116	5.50	240	2,576	10.73
Total ³ -----	2,205	8,653	3.92	2,017	8,241	4.09

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

¹Includes rubble.

²Includes curbing and monumental stone.

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

Strontium.—Strontium chemicals were produced from Mexican celestite by Chemical Products Corp. of Cartersville. The chemicals were used in electronics, ceramics, ferrites, television tubes, and various other specialty products.

Talc.—One producer, Southern Talc Co., mined talc underground in Murray County. The crude talc was transported to a milling facility in Chattsworth where it was ground for use in asphalt, carpet manufacture, composition roofing, and various other products. Production decreased from that of 1975 while the selling price increased.

METALS

Bauxite.—Georgia was one of three bauxite-producing States in the Nation during 1976. American Cyanamid Co. and the Mulcoa Div., C-E Minerals, Inc., produced bauxite for use in refractories and aluminum-based chemicals. Production from surface operations in Sumter County increased in tonnage and value over that of 1975.

Iron Ore.—The Lumpkin Mining Co. in Quitman County and the Luverne Mining Co. in Stewart County produced brown iron ore from surface operations. The ore is concentrated at onsite log washers, trucked to the nearest rail line, and shipped to Birmingham, Ala., where it is blended with foreign ores for steelmaking. Production

decreased significantly from that of 1975, according to industry spokesmen, because of a near depletion of the South Georgia brown iron field and the cost of reclaiming marginal ore properties.

Iron Oxide Pigments.—Ochre and umber production by the New Riverside Ochre Co. increased significantly. The ochre and umber were produced from surface mining operations in Bartow County and processed for mortar coloring agents, brick and tile, paints, and similar products.

Titanium-Zirconium.—Heavy mineral concentrates mined in Florida were shipped to the Folkston plant, owned by Humphreys Mining Co., for ilmenite and zircon recovery. The Folkston plant has used Florida concentrate for mill feed since 1974, when the Georgia deposits were depleted.

MINERAL FUELS

Coal.—Coal was mined intermittently in a three-county area in northwest Georgia by five companies during the year. All of the mines were surface operations and all of the coal, except for a small amount of weathered coal, was sold for cokemaking by domestic firms or it was exported to Brazil. The State's production totaled 186,000 tons valued at \$6.2 million.

Petroleum and Natural Gas.—Four test wells were drilled in the Coastal Plain area of the State during 1976; all were dry. Construction continued on the Elba Island

liquefied natural gas facility owned by Southern Natural Gas Co. At yearend the facility, designed to receive Algerian liquefied gas, was approximately 85% completed and was scheduled to receive the first shipments during the January-March period of 1978. Nine tankers costing \$1.2 billion have been completed or are currently under construction to transport the liquefied gas to Savannah and Cove Point, Md.

Solar Energy.—Ground was broken in

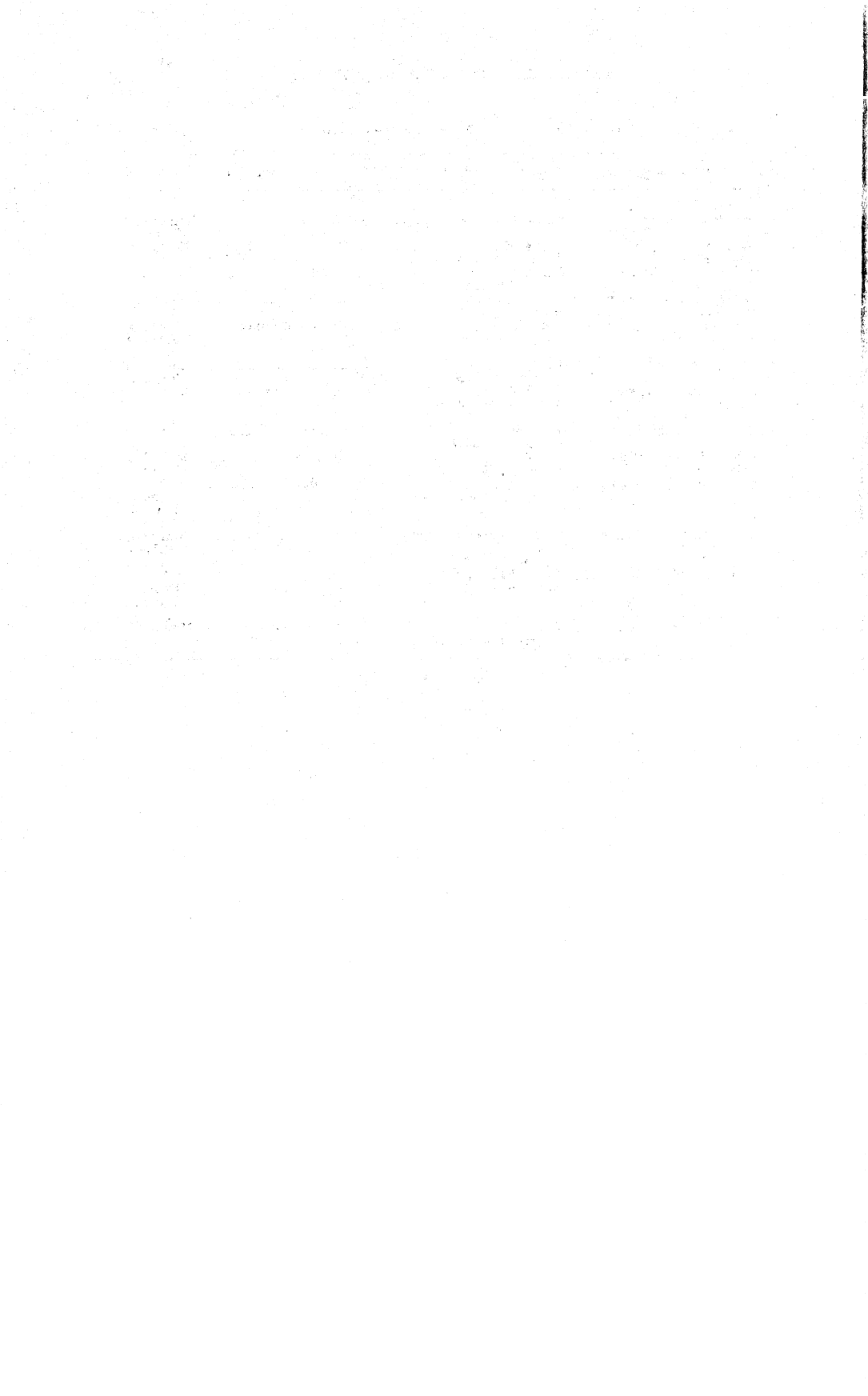
July at the Georgia Institute of Technology for a solar test facility funded by the Energy Research and Development Administration. The 400-kilowatt solar thermal test facility will be used primarily to test and evaluate experimental heat-exchangers including steam boiler-superheaters. The plant will consist of 550 heliostats which will reflect the sun's rays in a solar boiler. When completed, this facility will be the second largest in the world.

Table 15.—Principal producers

Commodity and company	Address	Type of activity	County
Barite, primary:			
New Riverside Ochre Co --	Box 387 Cartersville, Ga. 30120	Open pit mine ----	Bartow.
Paga Mining Co -----	Box 130 Cartersville, Ga. 30120	----do -----	Do.
Bauxite:			
American Cyanamid Co ---	Berdan Ave. Wayne, N.J. 07470	Open pit mine, drying plant.	Sumter.
C-E Minerals, Inc -----	901 East Eighth Ave. King of Prussia, Pa. 19406	Open pit mines, calcining plants.	Do.
Cement:			
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Plant -----	Polk.
Martin-Marietta Corp -----	18th Floor, Daniel Bldg. Birmingham, Ala. 35233	----do -----	Fulton.
Medusa Cement Co -----	Box 5668 Cleveland, Ohio 44101	----do -----	Houston.
Clays:			
American Industrial Clay Co	433 North Broad St. Elizabeth, N.J. 07207	Open pit mines ---	Warren and Washington.
Engelhard Minerals & Chemicals Corp.	Menlo Park Edison, N.J. 08817	----do -----	Decatur.
Freeport Kaolin Co -----	733 Third Ave. New York, N.Y. 10017	----do -----	Twiggs.
J. M. Huber Co -----	Thornall St. Edison, N.J. 08817	----do -----	Twiggs and Warren.
Feldspar:			
The Feldspar Corp -----	Box 99 Spruce Pine, N.C. 28777	Open pit mine and plant.	Jasper.
Gypsum:			
The Flintkote Co -----	400 Westchester Ave. White Plains, N.Y. 10604	Calcination plant -	Chatham.
Georgia-Pacific Corp -----	Box 311 Portland, Ore. 97207	----do -----	Glynn.
National Gypsum Co -----	327 Delaware Ave. Buffalo, N.Y. 14202	----do -----	Chatham.
Iron ore:			
Lumpkin Mining Co -----	Box 234 Greenville, Ala. 36037	Open pit mine, plant.	Quitman.
Luverne Mining Co -----	Box 409 Luverne, Ala. 36104	----do -----	Stewart.
Kyanite:			
C-E Minerals, Inc -----	433 South Gulph Rd. King of Prussia, Pa. 19406	Open pit mine, flotation plant.	Lincoln.
Mica:			
Franklin Mineral Products Co., Inc.	Box 0 Wilmington, Mass. 01887	Open pit mine, grinding mill.	Hart.
Thompson-Weinman & Co	Box 130 Cartersville, Ga. 30120	----do -----	Cherokee.
Peat:			
Shep Peat Co -----	Box 307 Colquitt, Ga. 31737	Bog -----	Miller.
Perlite, expanded:			
Armstrong Cork Co -----	1010 Concord Lancaster, Pa. 17604	Plant -----	Bibb.
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, Mass. 02140	----do -----	Gwinnett.
Rare-earth minerals:			
Humphreys Mining Co ----	Box 8 Folkston, Ga. 31537	----do -----	Charlton.

Table 15.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Brown Brothers Sand Co --	Howard, Ga. 31039 -----	Open pit mines ---	Talbot and Taylor.
Claussen-Lawrence Construction Co.	Box 4510 Augusta, Ga. 30907	Open pit mine ----	Richmond.
Colwell Construction Co ---	Box 6 Blairsville, Ga. 30512	----do -----	Upson.
Crawford County Mining Co., Inc.	3166 Maple Dr., NE. Atlanta, Ga. 30305	----do -----	Crawford.
Dawes Silica Mining Co ---	Box 470 Thomasville, Ga. 31792	Open pit mines ---	Dougherty, Effingham, Thomas.
Howard Sand Co -----	Box 118 Butler, Ga. 31006	----do -----	Talbot and Taylor.
The Scruggs Concrete Co., Inc.	Box 2065 Valdosta, Ga. 31601	Open pit mine ----	Cook.
Stone:			
Dalton Rock Products Co --	Box 1608 Dalton, Ga. 30720	Quarry -----	Whitfield.
Davidson Mineral Properties, Inc.	Box 458 Lithonia, Ga. 30058	Quarries -----	De Kalb and Fulton.
Dixie Lime & Stone Co ----	Box 998 Bridgeboro, Ga. 31744	----do -----	Clayton, Fayette, Mitchell, Monroe.
Georgia Marble Co -----	3460 Cumberland Pkwy., NW. Atlanta, Ga. 30303	----do -----	Gilmer and Pickens.
Vulcan Materials Co -----	Box 7324-A, 1 Office Park Birmingham, Ala. 35223	----do -----	Cobb, Douglas, Fulton.
Talc (soapstone):			
Southern Talc Co -----	Box F Chatsworth, Ga. 30705	Mines and mill --	Murray.



The Mineral Industry of Hawaii

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Hawaii Department of Land and Natural Resources for the collection of mineral data.

By William H. Kerns¹

Total value of mineral production in Hawaii in 1976 declined \$7.5 million (15%) to \$42.3 million, compared with the record high of \$49.7 million set in 1975. Most of this decrease resulted from declining building activity in the State, which reduced the demand for construction materials such as stone, cement, and sand and gravel.

Stone (excluding dimension stone) accounted for 50% of the total value of mineral production in the State in 1976 and declined \$4 million, compared with that of 1975; cement (masonry and portland) accounted for 44% of the total and declined \$2.3 million; and sand and gravel accounted for 4% and declined \$826,000.

The remainder was accounted for by lime, gem stones, pumice, and clays.

Stone was produced by 21 companies in Hawaii, Honolulu, Kauai, and Maui Counties and was used primarily as a bituminous and concrete aggregate. Cement was manufactured at two plants, both located in Honolulu County. Sand and gravel was produced by eight companies in Hawaii, Maui, and Kauai Counties and was used as concrete aggregate, roadbase and subbase, and fill. Pumice was produced by 13 operators in Hawaii, Kauai, and Maui Counties. Quick and hydrated lime were produced from coral at two plants, one

¹ State Liaison Officer, Bureau of Mines, Sacramento, Calif.

Table 1.—Mineral production in Hawaii¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ----- short tons--	12,809	\$762	10,516	\$663
Portland ----- do-----	455,834	19,942	328,317	17,747
----- do-----	5,538	250	W	W
Lime ----- thousand short tons--	318	912	330	636
Pumice ----- do-----	671	2,460	573	1,634
Sand and gravel ----- do-----	7,569	25,319	² 6,092	² 21,193
Stone ----- do-----				
Value of items that cannot be disclosed:				
Clays, gem stones, stone (dimension, 1976), and values indicated by symbol W -----	XX	65	XX	379
-----	XX	49,710	XX	42,252
Total 1967 constant dollars -----	XX	19,670	XX	^p 15,190

^p Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Hawaii, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Hawaii -----	\$4,617	W	Stone, pumice, sand and gravel.
Honolulu -----	39,031	\$34,256	Cement, stone, lime, clays.
Kauai -----	1,556	W	Stone, sand and gravel, pumice.
Maui -----	4,507	3,092	Sand and gravel, stone, pumice, lime, gem stones.
Total ¹ -----	49,710	42,252	

W Withheld to avoid disclosing company proprietary data; included in "Total."
¹ Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Hawaii business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	356.4	400.0	+12.2
Unemployment ----- do--	25.7	39.0	+51.8
Employment (nonagricultural):			
Mining ----- do--	(¹)	(¹)	(¹)
Manufacturing ----- do--	23.7	23.3	-1.7
Contract construction ----- do--	26.3	21.4	-18.6
Transportation and public utilities ----- do--	26.4	27.2	+3.0
Wholesale and retail trade ----- do--	33.7	38.0	+5.1
Finance, insurance, real estate ----- do--	24.3	24.8	+2.1
Services ² ----- do--	76.4	79.7	+4.3
Government ----- do--	82.0	84.8	+3.4
Total nonagricultural employment ----- do--	342.8	349.2	+1.9
Personal income:			
Total ----- millions--	\$5,706	\$6,198	+8.6
Per capita ----- do--	\$6,669	\$7,080	+6.2
Construction activity:			
Number of private and public residential units authorized--	12,240	8,225	-32.8
Value of nonresidential construction ----- millions--	\$162.2	\$117.3	-27.7
Value of State road contract awards ----- do--	\$31.1	\$51.0	+64.0
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	476	338	-29.0
Mineral production value:			
Total crude mineral value ----- millions--	\$49.7	\$42.3	-14.9
Value per capita, resident population ----- do--	\$57	\$48	-15.8
Value per square mile ----- do--	\$7,707	\$6,551	-15.0

^p Preliminary.

¹ Included with service.

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.

each in Honolulu and Maui Counties. Black, pink, and some gold coral was harvested from waters off Hawaii for use in making jewelry. Clays were mined at one pit in Honolulu County to produce brick. Vermiculite imported from Montana was exfoliated at one plant in Honolulu County.

Two petroleum refineries, both located at Barbers Point in Honolulu County, produced petroleum products from imported crude oil.

The second annual report of the Hawaii Coastal Zone Management Program was published.² The major goal of the program is to conserve and use the resources of the coastal zone with intelligence and good will to benefit all the people and their descendants. The report listed the proposed objectives and policies for managing Hawaii's

² Hawaii Department of Planning and Economic Development, Hawaii Coastal Zone Management Program, Second-Year Summary Report: 1975-1976. December 1976, 87 pp.

coastal zone and reviewed the legal aspects of coastal zone planning, analyzed organizational alternatives, and explained the public awareness and involvement process. Primary emphasis during this year was

public involvement in the planning process and gathering of information about Government permits and regulations required in coastal zone areas.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Two cement plants were operated in Hawaii, one by Kaiser Cement & Gypsum Corp. near Nanakuli and a second by Cyprus Hawaiian Cement Corp. near Ewa, both in Honolulu County. Shipments of portland cement totaled 328,317 tons, a 28% decline compared with that of 1975. The total value of these shipments was \$17.7 million, 11% below that of 1975. Shipments of masonry cement totaled 10,516 tons, 18% below that of 1975, and were valued at \$663,000, a 13% decline.

Of the total portland cement, 81% was used for ready-mix concrete; 10%, by concrete product manufacturers; 6%, by building material dealers; 2%, by highway contractors; and the remainder, by other contractors, miscellaneous customers, and Government agencies.

Raw materials consumed in manufacturing cement at the two plants included coral and basalt mined locally and imported silica sand, gypsum, and clinker. The two plants used fuel oil to fire their kilns and purchased electrical power generated locally.

Cyprus Hawaiian Cement Corp. manufactures and sells portland cement, masonry cement, and calcium silicate in Hawaii. According to the company's 1976 Annual Report to Stockholders, sales of all products in 1976 totaled 251,000 tons, compared with 309,000 tons in 1975. The reduction was caused by a decline of nearly one-third in Hawaiian cement consumption. The company also mines and sells limestone aggregate and markets white portland cement imported from producers outside Hawaii.

Clays.—Pacific Clay Corp. mined common clay near Waimanalo, Honolulu County, and used it for making brick at a plant in Campbell Industrial Park near Ewa in Honolulu County.

Gem Stones.—Black, pink, and some gold coral was harvested in waters surrounding the Hawaiian Islands to provide

the raw material for local jewelry manufacturing, which was projected to gross over \$10 million per year and employ over 500 persons. The major jewelry producer, Maui Divers of Hawaii, Ltd., dedicated in Honolulu a new plant, which houses 220 employees and has room for expansion. Maui Divers includes the fashion jewelry division, Pele Collection, and a wholly owned subsidiary, Deepwater Explorations, Ltd., which handles diving and coral-collecting operations. The company harvests pink coral off Makapuu in the Molokai Channel with a deep-diving submarine at depths of up to 1,200 feet. Black coral is harvested by independent scuba divers in waters off Maui and Kauai Islands at depths of 150 to 250 feet.

Lime.—Two companies produced lime for use in sugar refining and for finishing lime. GasprO, Ltd., produced quick and hydrated lime from coral at Waianac, Honolulu County, and Hawaiian Commercial & Sugar Co., Ltd., produced hydrated lime at Paia, Maui County.

Pumice and Volcanic Cinder.—Thirteen operators mined pumice and volcanic cinder at 14 pits for use as concrete aggregate, roadbase and surface, landscaping, and fill material. Output increased 4% but total value decreased 30% compared with that of 1975. Production was reported from Hawaii, Kauai, and Maui Counties.

Sand and Gravel.—Output of sand and gravel declined 15% in quantity and 34% in total value compared with those of 1975. Eight operators produced 573,000 tons of sand and gravel from nine pits. Two pits were in Hawaii County, four were in Kauai County, and three were in Maui County. Of the total State output, 32% was used as roadbase and coverings; 23%, as concrete aggregate; 17%, as fill; 6% each, in concrete products and as asphaltic concrete aggregates and other bituminous mixtures; and the remaining 16%, for other miscellaneous uses.

Table 4.—Hawaii: Construction sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value
Processed:				
Sand -----	270	946	187	788
Gravel -----	W	W	W	W
Unprocessed: Sand and gravel -----	402	1,445	W	W
Total -----	² 671	2,391	573	1,634

W Withheld to avoid disclosing company proprietary data; included with "Processed sand" (1975) and in "Total (1976)."

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant for blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

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

One of the operators produced a total in excess of 300,000 tons of sand and gravel in 1976. The operators, in descending order of tonnage produced, were HC&D, Ltd., Amelco Corp. (Maui Concrete & Aggregates, Inc.), Louis K. Rego Trucking Co., Honokaa Sugar Co., Kekaha Sugar Co. Ltd., Changs Express, Kan Sugar Co., and Lihue Plantation Co., Ltd.

Stone.—Production of crushed stone declined 20% in quantity and 16% in value of output compared with that of 1975. Twenty-one companies produced stone at 33 quarries, of which 9 were located in Honolulu County; 16, in Hawaii County; 3, in Maui County; and 5, in Kauai County. Of the total production, 79% came from Honolulu County; 12%, from Hawaii County; 5%, from Maui County; and 4%, from Kauai County. One-third of the State's total output was used as bituminous aggregate; 25%, as concrete aggregate; 12% each, to manufacture cement and for dense-graded roadbase stone; 7%, for other roadstone; and the remainder as fill, surface treatment aggregate, agricultural limestone, chemicals, and other uses.

Leading producers in the State were Lone Star Industries, HCD, Ltd., Pacific Concrete & Rock Co., Ltd., Cyprus Hawaiian Cement Corp., Herbert Tanaka Co., Hawaiian Bitumuls & Paving Co., Ltd., James W. Glover, Ltd., Grove Farm Co., Inc., and Kaiser Cement & Gypsum Corp. Output from three quarries each exceeded 500,000 tons for the year and together accounted for 57% of the State's total. Ten other quarries, each with production between 100,000 and 400,000 tons for the year, supplied an additional 37% of the total. An

additional 20 quarries supplied the remaining 6%.

In addition to the crushed stone, James W. Glover, Ltd., and James Kuwana each quarried small quantities of dimension stone for use as rubble and rough blocks.

After nearly 3 years of construction, HC&D, Ltd.'s \$9 million Mansand plant at Kapaa Quarry was dedicated in mid-1976. Conceived more than 10 years ago, the facility fills the void left by cessation of the firm's Molokai sand-mining activities. When such mining was banned on Oahu Island some 20 years ago, local concrete manufacturers turned to Molokai's Papohaku Beach as the major sources of coral sand. In 1970, Molokai sand mining was ordered halted by June 1975 for environmental reasons. Financed by HC&D's parent company, Ameron, the new Mansand plant grinds out a product made from crushed basalt, which is then dried, screened, and blended as sand for concrete, asphaltic concrete, sandblasting, and other end products. HC&D already quarries basalt rock at the Kapaa Quarry to make coarse aggregate. A major feature of the new facility is its \$1 million pollution control system, which will filter and collect rock dust produced in the manufacturing process. Other features include electronic scales and closed circuit television for facilitating weigh-ins.

Construction completed in Hawaii during 1976 amounted to \$1.01 billion, the third highest volume on record and a drop of 11% from the peak set in 1975.³ The vol-

³ Bank of Hawaii. Construction in Hawaii, 1977. May 1977, 40 pp.

Table 5.—Hawaii: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	2,447	7,413	2,022	6,831
Concrete aggregate -----	2,144	9,081	1,500	6,728
Cement manufacture -----	910	1,916	736	1,795
Dense-graded roadbase stone -----	1,209	3,676	730	2,309
Roadstone -----	496	1,681	438	1,098
Fill -----	45	97	W	W
Surface treatment aggregate -----	48	191	151	633
Agricultural limestone -----	28	120	29	151
Chemicals -----	7	32	10	55
Bedding material -----	7	31	W	W
Other uses ² -----	218	979	476	1,592
Total ³ -----	7,559	25,220	6,092	21,193

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

¹ Includes traprock, limestone, and miscellaneous stone.

² Includes stone used for macadam aggregate, riprap and jetty stone, lime manufacture, terrazzo and exposed aggregate (1975), bedding material (1976), mineral food (1976), other uses (1975), and uses indicated by symbol W.

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

ume of private construction authorized was \$46 million in 1976, compared with a record high of \$766 million set in 1974. Most of the decline during 1976 focused on condominium apartment construction. The Federal, State, county, and city government construction-bid openings totaled \$330 million, compared with the peak of \$506 million in 1975.

Vermiculite.—Vermiculite of Hawaii, Inc., exfoliated vermiculite from Montana at a plant in Honolulu, Honolulu County. Output was comparable to that of 1975. Of the total output, 40% was used as plaster aggregate; 20% each, as roofing aggregate and soil conditioner; and 10% each, as concrete aggregate and loose fill insulation.

MINERAL FUELS

Hawaii's predominate source of commercial energy was imported oil, augmented to a minor degree by boilers fired by bagasse, a sugar cane byproduct, and a few small hydroelectric generators.⁴ In 1976, Hawaii imported 39.6 million barrels of crude oil and petroleum products from more than 20 foreign countries, including an insignificant share from mainland United States. The principal sources of crude oil for Hawaii's two refineries, one operated by Standard Oil Co. and the other by Pacific Resources, Inc., included Indonesia, Saudia Arabia, and Venezuela. Southeast Asia, Angola, Oman, Bahrain,

and Venezuela supplied the bulk of distillate and residual fuel oil, a large share of which was for electric power generators. Jet fuel came from 14 sources, the largest of which were Singapore, the Bahamas, and Southeast Asia. Other petroleum products, including gasoline, butane, propane, and lubricating oil, originated largely in Southeast Asia and Indonesia.

Currently, an average of 100,000 barrels per day of crude petroleum flows into Oahu together with 45,000 barrels of petroleum products, about 7% of which go to neighboring islands. Electric utilities, domestic and foreign airlines, the military, service stations, gas manufacturing, surface shipping, and agricultural processing account for more than 90% of the petroleum products distributed in Hawaii.

Responding to the fuel crisis of 1974 and because of Hawaii's heavy dependence on imported oil for its energy requirements, the Governor established an advisory task force on energy policy. Reporting to the task force was a committee on alternate energy sources, which examined the technical and economic feasibility of a wide range of energy alternatives. Several of these alternatives offer the promise of augmenting Hawaii's energy requirements, but in aggregate will not eliminate Hawaii's heavy dependence on oil during the next decade.

⁴ Bank of Hawaii, Hawaii 1977. 27th Annual Economic Review. July 1977, 48 pp.

In alternate energy programs, Hawaii is striving for decreased dependence on imported petroleum. The report published by the Committee on Alternative Energy Sources⁵ cited the five most promising resources as geothermal, ocean thermal energy conversion, wind, solar, and bioconversion (including solid waste), but noted that there were no short-term solutions. Hawaii's efforts have been directed toward developing a solid technical capability at the University of Hawaii, procuring substantial and continuing Federal support, and planning for development of the most viable energy resources at the earliest possible time. The report discussed the many research facilities already in existence and working directly or indirectly on energy-related problems. Sixty energy-research projects and programs completed, in progress, or about to begin were tabulated and reviewed.

The State Energy Resources Coordinator is charged with the responsibility of formulating plans, programs, and financial requirements for the optimum conservation, management, and development of Hawaii's energy resources. A report reviewing the coordinator's activities for 1976 was published.⁶ The coordinator is assisted in his energy responsibilities by two staff offices within the Department—the State Energy Office and the Center for Science Policy and Technology Assessment.

The Hawaii Geothermal Project (HGP) was organized to focus the efforts of the University of Hawaii, the State, and Hawaii County on the identification, generation, and utilization of geothermal energy on the island of Hawaii. A summary of phase 1 and 2 activities was published.⁷ A paper on the geothermal developments in Hawaii⁸ was given at the Federal-State Conference on Geothermal Energy sponsored by the National Governors' Conference and the Energy Research and Development Administration in Oakland, Calif., in March 1976.

Phase 2 of HGP was the exploratory drilling phase and included both a research drilling program and a continuation of the support services. Based upon phase 1 field testing and analysis, a site was selected in the Puna area of the island of Hawaii for drilling a 6,000-foot test hole designated as well HGP-A, the purpose of which was to obtain scientific data on the nature and

extent of conventional geothermal resources. Temperature, rock cores, and water samples were taken intermittently throughout the full drilling depth, and electric logging was conducted down to the point at which the temperature exceeded the capability of the instrument. Drilling commenced on December 10, 1975, and was completed on April 27, 1976. Phase 3 of HGP, well testing and scientific analysis, was begun on well HGP-A. Down-hole temperatures in excess of 300° C (570°F) were measured, and were well within the temperature range of commercial power generation. But, according to report, it was too early to tell whether sufficient permeability exists at sufficient depths to support a geothermal reservoir. A comprehensive well-testing program will continue. A report describing the legal and public policy-setting for geothermal resource development in Hawaii was published.⁹

Pursuant to Chapters 182 and 91 of the Hawaii Revised Statutes and other applicable laws, the State Board of Land and Natural Resources held a series of public hearings in April and May at various places in Hawaii to consider for adoption and receive testimony on the proposed rules and regulations governing geothermal exploration and the mining and leasing of government-owned geothermal mineral resources in the State of Hawaii. The proposed rules and regulations are being promulgated under Chapter 182, as amended, Reservation and Disposition of Government Mineral Rights.

Thermal Power Co. of California (TPC) signed a joint-venture agreement with Honolulu-based Geothermal Exploration & Development Co. (GEDCO) to develop a

⁵ Hawaii Natural Energy Institute. University of Hawaii and Hawaii Department of Planning and Economic Development. *Hawaii's Natural Energy Resources 1976*. June 1, 1976, 60 pp.

⁶ Hawaii Department of Planning and Economic Development. *Energy Resources Coordinator 1976 Annual Report*. March 1977, 48 pp.

⁷ University of Hawaii. *The Hawaii Geothermal Project. Initial Phase 2 Program Report*. February 1976, 8 pp.

⁸ Grabbe, E. M., and R. M. Kamins. *Geothermal Developments in the State of Hawaii*. Pres. at Federal-State Conference on Geothermal Energy, Oakland, Calif. Mar. 10, 1976, 20 pp.

⁹ Kamins, R. M., and D. Kornreich. *Legal and Public Policy Setting for Geothermal Resource Development in Hawaii*. Hawaii Geothermal Project, University of Hawaii. February 1976, 38 pp.

geothermal field on the island of Hawaii in the Puna field. TPC will act as the operator in the joint venture but has no plans to begin drilling until geothermal lease rights have been signed with fee owners in the Puna area. This may have to await the adoption of regulations governing geothermal exploration and the mining and leasing of government-owned geothermal mineral resources in the State of Hawaii.

METALS

Manganese.—A project report on the ferromanganese deposits of the Hawaiian Islands, funded jointly by the Marine Affairs Coordinator of the State of Hawaii, and the Sea Grant Program of Hawaii through the Office of Sea Grant, National Oceanic and Atmospheric Administration, was published.¹⁰ The report summarized the progress and data accumulated to date on a 4-year investigation and presents pre-

liminary conclusions concerning the deposits and their economic potential.

In midyear, a team of research scientists began a 3-month preliminary environmental study of an area 2,500 miles southeast of Hawaii in advance of an industry move to mine manganese nodules from the ocean floor. The area is to be studied by researchers from the National Oceanic and Atmospheric Administration, U.S. Geological Survey, Texas A&M University, and the Universities of Hawaii and Washington. Research will be undertaken aboard the U.S. Department of Commerce vessel *Oceanographer* to develop physical, chemical, sedimentological, and biological baselines so that ecological changes can be determined after mining is in progress.

¹⁰ Frank, D. J., M. A. Meylan, J. D. Craig, and G. P. Glasby. Ferromanganese Deposits of the Hawaiian Archipelago. Hawaii Inst. Geophys., Univ. Hawaii, UNIHI-SEAGRANT-CR-77-01, HIG-76-14, December 1976, 71 pp.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	Island
Cement:			
Cyprus Hawaiian Cement Corp.	1600 Kapiolani Blvd. Honolulu, Hawaii 96814	Cement plant ----	Oahu.
Kaiser Cement & Gypsum Corp.	Waianae Plant 300 Lakeside Dr. Oakland, Calif. 94666	----do -----	Do.
Clays: Pacific Clay Corp -----	547 Halekauwila St. Honolulu, Hawaii 96813	Open pit mine ---	Do.
Lime:			
GasprO, Ltd -----	Box 30707 Honolulu, Hawaii 96820	Rotary kiln and continuous hydrator.	Do.
Hawaiian Commercial & Sugar Co., Ltd.	Box 266 Puunene, Hawaii 96784	----do -----	Maui.
Pumice and volcanic cinder:			
Fong Construction Co., Ltd.	237 Dairy Rd. Kahului, Hawaii 96732	Open pit mine ---	Do.
Grove Farm Co -----	Lihue, Hawaii 96766	----do -----	Kauai.
HC&D, Ltd -----	Box 190 Honolulu, Hawaii 96810	----do -----	Molokai.
Hilo Coast Processing Co ---	Pepeekeo, Hawaii 96783	----do -----	Hawaii.
Laupahoehoe Sugar Co ---	Papaaloa, Hawaii 96780	----do -----	Do.
McBride Sugar Co -----	Eleele, Hawaii 96705	----do -----	Kauai.
Sand and gravel:			
HC&D, Ltd -----	Box 190 Honolulu, Hawaii 96810	----do -----	Molokai.
Maui Concrete & Aggre- gates, Inc.	3 Central Ave. Wailuku, Hawaii 96793	----do -----	Maui.
Louis K. Rego Trucking Co.	Lihue, Hawaii 96766	----do -----	Kauai.
Stone:			
Cyprus Hawaiian Cement Corp.	1600 Kapiolani Blvd. Honolulu, Hawaii 96814	Quarry -----	Oahu.
James W. Glover, Ltd ----	Box 275 Hilo, Hawaii 96720	----do -----	Hawaii.
Grove Farm Co., Inc -----	Puhi Rural Station Lihue, Hawaii 96766	----do -----	Kauai.
Hawaiian Bitumuls & Paving Co., Ltd.	Box 2240 Honolulu, Hawaii 96804	----do -----	Oahu.
HC&D, Ltd -----	Box 190 Honolulu, Hawaii 96810	----do -----	Maui and Oahu.
Hilo Coast Processing Co --	Box 13 Pepeekeo, Hawaii 96783	----do -----	Hawaii.
Kaiser Cement & Gypsum Corp.	Waianae Plant 300 Lakeside Dr. Oakland, Calif. 94666	----do -----	Oahu.
Lone Star Industries -----	400 Alabama St. San Francisco, Calif. 94110	----do -----	Do.
Pacific Concrete & Rock Co., Ltd.	2344 Pahounui Dr. Honolulu, Hawaii 96819	----do -----	Maui, Molokai, Oahu.
Herbert Tanaka Co -----	Waiana, Hawaii 96792	----do -----	Oahu.
Yamada and Sons -----	Box 577 Hilo, Hawaii 96720	----do -----	Hawaii.
Vermiculite (exfoliated):			
Vermiculite of Hawaii, Inc.	842-A Mapunapuna St. Honolulu, Hawaii 96819	Exfoliating plant..	Oahu.

The Mineral Industry of Idaho

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Idaho Bureau of Mines and Geology for collecting information on all minerals except fuels.

By D. W. Lockard¹ and E. H. Bennett²

Idaho's mineral production value in 1976 totaled \$210 million, 10% less than the 1975 value of \$234 million, which was an alltime high. This decrease can be attributed primarily to two factors: The labor strike at the Sunshine mine, the Nation's largest silver producer; and the decline in phosphate rock value from operations in the southeastern part of the State.

Twenty mineral commodities were produced; 8 were metallics and 12 were non-metallics or industrial minerals. Value increases were achieved by five metallics and eight nonmetallics.

Silver regained its position as the State's leading mineral commodity in terms of value, replacing phosphate rock which fell to second, followed by zinc and lead. Metallics accounted for 60% of the mineral revenues, with practically all metallic mineral production coming from the Coeur d'Alene district.

The leading nonmetallic, phosphate rock, experienced a production increase but a significant 35% decline in value. Value increases by cement and lime exceeded 35%.

Idaho ranked 33d in mineral production value out of the 50 States but was first in the production of silver; second in lead, antimony, and natural abrasives; third in vanadium; and fifth in zinc. The production value attained by the State was \$2,516 per square mile and \$253 per capita.

As in previous years, over 80% of Idaho's mineral values was produced from two mining areas—the Coeur d'Alene silver-base metal district in Shoshone County and the

phosphate region in Bingham and Caribou Counties.

In the Coeur d'Alene district, a labor strike, which began at the Sunshine mine in March 1976 and continued into 1977, resulted in greatly reduced silver and antimony output. Sunshine was subsequently replaced by the Galena mine as the Nation's number one silver producer for 1976. The silver production decline would have been greater had not the new Coeur mine, owned by Coeur d'Alene Mines and operated by ASARCO Inc., come on-stream in February. The Coeur, after an investment cost exceeding \$20 million, ranked third in the State behind Hecla Mining Co.'s Lucky Friday mine in silver produced. Production levels at the other major producers in the district remained fairly constant.

New development work was progressing at the Dayrock (shaft sinking and drifting), Sunshine (shaft sinking), and the Galena (new vein on the 4,600 level). The Silver Cable mine near the Idaho-Montana border was being reactivated and the Nabob mill on Pine Creek became operational at a feed rate of 75 tons per shift. Hecla's projects included the South Morning, Alice Consolidated, Abot North, West Independence, and the Consolidated Silver property. ASARCO notified Hecla that it terminated its exploration agreement on the Consolidated Silver project. Earth Resources Corp.

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Table 1.—Mineral production in Idaho ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ore and concentrate				
short tons, antimony content...	613	W	133	\$282
Clays ----- thousand short tons...	30	\$284	W	W
Copper (recoverable content of ores, etc.) ----- short tons...	3,192	4,099	3,362	4,680
Gem stones -----	NA	120	NA	126
Gold (recoverable content of ores, etc.) ----- troy ounces...	2,529	408	2,755	345
Lead (recoverable content of ores, etc.) ----- short tons...	50,395	21,670	53,636	24,780
Pumice ----- thousand short tons...	111	187	W	W
Sand and gravel ----- do...	6,881	12,768	² 6,549	² 11,504
Silver (recoverable content of ores, etc.)				
thousand troy ounces...	13,868	61,297	11,561	50,292
Stone ----- thousand short tons...	3,316	8,952	³ 3,462	³ 9,122
Zinc (recoverable content of ores, etc.) ----- short tons...	40,926	31,922	46,586	34,473
Value of items that cannot be disclosed:				
Barite, cement, garnet (abrasive), gypsum, iron ore (usable, 1975), lime, perlite, phosphate rock, pumice, sand and gravel (industrial, 1976), stone (dimension, 1976), tungsten ore, vanadium, and values indicated by symbol W -----	XX	92,081	XX	74,642
Total -----	XX	233,788	XX	210,246
Total 1967 constant dollars -----	XX	92,510	XX	^P 75,583

^P Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

³ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Idaho, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Ada	\$2,101	W	Sand and gravel, gold, silver.
Adams	916	\$1,761	Copper, silver, stone, gold.
Bannock	W	W	Cement, stone, sand and gravel.
Bear Lake	W	W	Sand and gravel.
Benewah	W	W	Garnet, stone, sand and gravel, clays.
Bingham	W	W	Phosphate rock, stone, sand and gravel, pumice.
Blaine	600	W	Sand and gravel, barite, silver, copper, gold, lead.
Boise	W	1	Stone.
Bonner	142	W	Sand and gravel, silver, stone, zinc, lead, gold, copper.
Bonneville	W	W	Sand and gravel, lime, pumice, stone.
Boundary	6	37	Sand and gravel, stone.
Butte	W	--	--
Canyon	W	W	Sand and gravel, lime.
Caribou	W	43,166	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	W	Sand and gravel, stone.
Clark	W	W	Sand and gravel, stone, lead, silver.
Clearwater	701	881	Stone, sand and gravel.
Custer	2,897	2,704	Zinc, silver, lead, sand and gravel, copper, gold.
Elmore	W	434	Sand and gravel, gold, clays, silver, stone.
Franklin	61	80	Sand and gravel, stone.
Franklin	341	192	Stone, sand and gravel.
Fremont	939	897	Sand and gravel, stone, gold, silver, sand and gravel.
Gem	W	462	Sand and gravel.
Gooding	W	W	Stone, sand and gravel, silver, gold, copper, lead.
Idaho	1,264	113	Stone.
Jefferson	W	W	Sand and gravel.
Jerome	W	W	Sand and gravel, stone, gold, lead, silver, zinc, copper.
Kootenai	1,112	W	Stone, clays.
Latah	W	W	Sand and gravel, stone, gypsum, lead, silver, gold, copper.
Lemhi	W	58	Stone.
Lewis	W	W	Sand and gravel.
Lincoln	W	403	Do.
Madison	W	W	Lime, sand and gravel.
Minidoka	W	W	Stone, sand and gravel.
Nez Perce	W	W	Perlite, pumice.
Oneida	W	1	Sand and gravel.
Owyhee	248	500	Do.
Payette	38	31	Do.
Power	W	110,977	Silver, zinc, lead, copper, gold, antimony, sand and gravel, stone.
Shoshone	W	W	Lime, sand and gravel.
Teton	260	W	Sand and gravel, tungsten, stone.
Twin Falls	W	W	Stone, sand and gravel.
Valley	W	W	Stone, sand and gravel.
Washington	W	W	Stone, sand and gravel.
Undistributed ²	222,162	47,552	
Total	233,788	210,246	

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

¹ Camas County is not listed because no production was reported.

² Includes value of mineral production which 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 Idaho business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force.....thousands..	357.7	366.0	+2.3
Unemployment.....do.....	24.9	21.0	-15.7
Employment (nonagricultural):			
Mining.....do.....	3.7	3.4	-8.1
Manufacturing.....do.....	47.8	51.9	+8.6
Contract construction.....do.....	16.1	17.4	+8.1
Transportation and public utilities.....do.....	16.3	17.1	+4.9
Wholesale and retail trade.....do.....	67.8	72.8	+7.4
Finance, insurance, real estate.....do.....	14.4	15.3	+6.3
Services.....do.....	44.6	48.4	+8.5
Government.....do.....	62.3	64.1	+2.9
Total nonagricultural employment.....do.....	273.0	¹ 290.2	+6.3
Personal income:			
Total.....millions..	\$4,196	\$4,684	+11.6
Per capita.....do.....	\$5,159	\$5,640	+9.3
Construction activity:			
Number of private and public residential units authorized.....	8,172	9,540	+16.7
Value of nonresidential construction.....millions..	\$56.7	\$80.7	+42.3
Value of State road contract awards.....do.....	\$46.5	\$50.0	+7.5
Shipments of portland and masonry cement to and within the State.....thousand short tons..	396	513	+29.5
Mineral production value:			
Total crude mineral value.....millions..	\$233.8	\$210.2	-10.1
Value per capita, resident population.....do.....	\$288	\$253	-12.2
Value per square mile.....do.....	\$2,798	\$2,516	-10.1

^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.

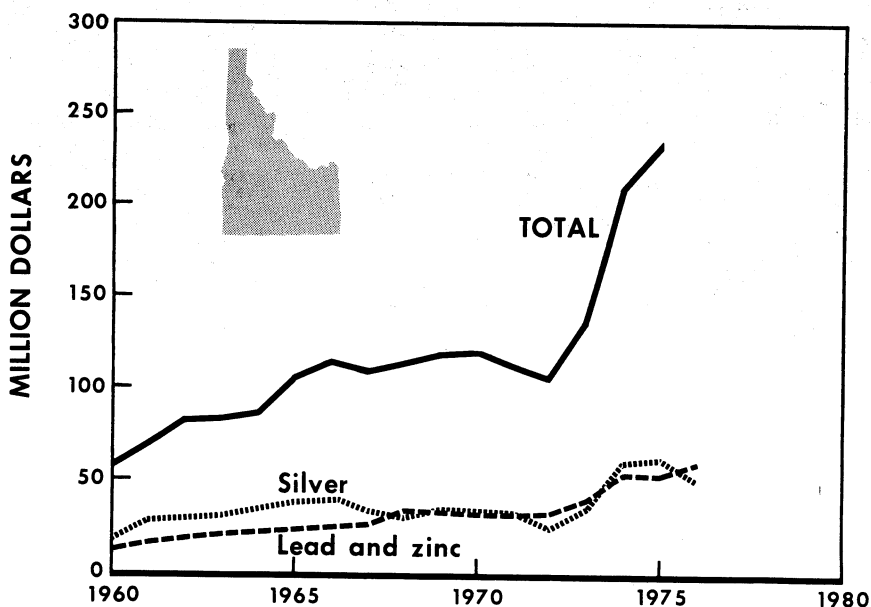


Figure 1.—Value of silver, lead, and zinc, and total value of mineral production in Idaho.

completed a joint venture agreement with Johns-Manville Corp. to explore and develop the Niagara property near Murray. Diamond drilling projects were underway at the Royal Apex Silver mine, Gold Creek mine, and Burke Canyon mine; all properties are within the district. Downward vein extensions were explored at the Atlas and Day Mine Inc.'s Tamarack and Hercules properties.

ASARCO's Coeur mine was formally dedicated on June 4. The Coeur has a 450-ton-per-day capacity with probable reserves of 880,000 tons averaging 21 ounces of silver per ton and 0.78% copper. Employment should reach 130 people when in full production.

North of the Coeur d'Alene district, Silver Butte Mining Co. acquired most of the old Talache silver mine on Lake Pend Oreille. Also in Bonner County and north into Boundary County, uranium exploration increased substantially. Reports indicated that Kerr-McGee Corp., Pechiney-Ugine-Kuhlman and Utah International Inc., have consolidated land holdings along the Washington and Idaho border. These firms believe uranium occurrences similar to those in northeastern Washington may occur in the Idaho panhandle.

In the western part of the State near the Seven Devils, mining companies were actively searching for disseminated copper and silver deposits in volcanic rocks. Anglo-Bomarc Mines, Ltd., and Canadian Superior Exploration Ltd., have agreed to a joint venture in developing the Hercules mine in Adams County.

Exploration in the central part of the State continued to accelerate during the year. In Valley, Custer, and Lemhi Counties, numerous companies were searching for tungsten and molybdenum occurrences. An environmental impact assessment was completed for Tuscarora Mining Co.'s Thompson Creek molybdenum deposit.

The phosphate-producing industry in southeastern Idaho was still awaiting the completion of the final environmental impact statement (EIS) on proposed expansion. The draft EIS was released in May and described plans for developing 16 new mines over the next 25 years; the new mines would come onstream as reserves as the present operations become depleted. The Governor has requested a 3-month delay in issuing the final statement in order to

increase State involvement. No Federal phosphate leases in the area have been issued since 1972. During the first 6 months of the year, mineral royalties, which are mostly phosphate generated, approached \$700,000, of which \$243,000 was returned to the State. Late in the year, the State Land Board approved the reclamation plan for Alumet's initial work on 116 acres of privately owned ground.

In 1976, mineral processing within the State added an estimated \$500 million to the value of the raw mineral production. These activities were mainly centered in Shoshone County (metallics) and Caribou and Power Counties (nonmetallics).

As in most previous years, there were no fossil fuels produced in the State in 1976. Interest remained high, however, as a result of recent oil and gas discoveries in Wyoming and Utah in the "overthrust belt." By the end of the year, the Department of Lands had recorded over 1 million acres under lease and application. During the year, two dry wells were completed—one in Ada and the other in Caribou County; total footage drilled exceeded 17,000 feet. Drilling continued on one well in Bonneville County by American Quasar and a test well was begun in Bear Lake County. Interest continued in assessing the coal resources near Driggs in Teton County. Geothermal resources have not been up to expectations. Of 536 State leases granted in 1975, 398 were relinquished during March, as a result of a combination of problems such as an unfavorable tax situation, difficulty in securing permits, and ownership. The Bureau of Land Management (BLM) also has 373 pending applications for geothermal leases. During the year, 57 competitive leases representing 93,585 acres were issued; 44 were in Owyhee County. Ten competitive leases for 20,964 acres were approved; bonus bids ranged from \$2.13 to \$63 per acre.

Many environmental matters concerned Idaho in 1976 ranging from emissions at The Bunker Hill Co. smelter complex to the withdrawal of lands from mineral entry. At the smelter, atmospheric conditions forced a curtailment in operations because State air pollution standards were exceeded. To alleviate the problem, two new smokestacks were under construction—a 715-foot stack at the lead smelter and a 610-foot stack at the electrolytic zinc plant. Both

stacks are expected to be fully operational by July 1978 and will have cost \$11 million. Hearings were held concerning Bunker Hill's request for a variance on "Regulation S" regarding air pollution. The request was subsequently denied. A proposal to dredge in the St. Joe River at Scat Creek was delayed due to litigation on the Idaho Dredge Mining Act; U.S. Forest Service approval of mining and reclamation plans is also needed. An EIS was still in progress for the Woodrat Mountain kyanite deposit in Clearwater County. Environmental studies are pending on many geothermal and oil and gas lease applications in the eastern and southeastern sections of the State. Lands withdrawn from mineral entry in the Glidden Lake area north of the Coeur d'Alene district were reopened after public hearings were held.

Legislation and Government Programs.—The second regular session of the 43d Idaho Legislature considered 12 bills that would affect the State's mineral industry. A provision signed into law now gives 10% of the mineral lease funds paid to the State from Federal leases to the county where the mining occurred. Bills which failed included one that would have revised the mine license tax on phosphate rock. Other legislation that was left in committee included regional impact land use measures and economic impact statements on projects that affect the environment.

The Federal Bureau of Mines had numerous mineral research projects ongoing within the State. The Western Field Operations Center, Spokane, Wash., continued field investigations on wilderness areas in the Scotchman Peak (Shoshone and Bonner Counties) and Boulder-Pioneer areas (Custer and Blaine Counties). The Salt Lake City (Utah) Metallurgical Laboratory, working in conjunction with The Bunker Hill Co., made a computer analysis of the overall efficiency of the natural gas utilization in the H_2S generator at the citrate process pilot plant. At the Albany (Oreg.) Metallurgical Research Center, Idaho phosphate rock was tested to determine what available byproducts, such as fluorine, vanadium, and chromium could be recovered from altered and unaltered ore. Hecla Mining Co. undertook pilot plant studies of the fused-salt electrolysis of lead chloride process that was developed by the

Bureau's Reno (Nev.) Metallurgy Research Center. The Center also ran amenability tests utilizing the heap leach cyanide extraction for gold and silver on some Idaho deposits.

The Spokane Mining Research Center, in cooperation with the mining companies in the Coeur d'Alene district, tested deep level destressing techniques in an attempt to alleviate and monitor rock burst problems, and continued to investigate problems associated with dewatering of stope fill. A funded grant to the University of Idaho examined the occurrence and methods of control of leakage from tailings ponds at the Bunker Hill complex. Two workshops were held in the State to solicit industry input to and evaluation of the Bureau's mining research program as it related to Idaho's mining industry.

In 1976, the Idaho Bureau of Mines and Geology added three geologists to its staff. Reconnaissance geologic and geochemical studies were undertaken in Owyhee County, the Panther Creek area in Lemhi County, a part of the southern Idaho Batholith between the North and South Forks of the Boise River in Boise and Elmore Counties, the South Fork of the Salmon River-Chamberlain Basin area in Valley and Idaho Counties, and a geochemical sampling of the Loon Creek-Yellowjacket area in Custer and Lemhi Counties. A long-range geologic reconnaissance of the entire Idaho Batholith (plutonic complex) was initiated to help define new parameters for mineral exploration and inventory. Environmental studies were conducted on the impact of phosphate mining on water resources in southeastern Idaho—a study in cooperation with the BLM on toxic soil material in Butte County and a study in cooperation with the Idaho Department of Health and Welfare to determine the level and source of lead pollution in the soils around the Bunker Hill smelter.

Employment.—Employment in the mineral industry decreased during the year; average men working and man-hours worked fell by 5% and 9%, respectively. This falloff was the direct result of the Sunshine strike. Idaho miners are the second highest paid employees in the State with a weekly average of \$273.95. Total number of accidents decreased by 4, and nonfatal disabling injuries decreased by 38%. Of the fatalities, two were at under-

Table 4.—Idaho: Employment and injury experience ¹

Year and industry	Average men working daily	Man-hours worked (thousands)	Number of disabling injuries reported		Frequency ² (injury rates per million man-hours)	
			Fatal	Nonfatal	Fatal	Nonfatal
1975:						
Metal -----	2,674	5,128	5	241	0.97	46.99
Nonmetal -----	962	1,900	1	28	.53	12.11
Sand and gravel ---	468	351	--	6	--	17.07
Stone -----	240	141	1	--	7.07	--
Total ³ -----	4,344	7,521	7	270	1.01	35.90
1976:						
Metal -----	2,507	4,430	2	142	.45	32.05
Nonmetal -----	962	1,836	1	24	.54	13.07
Sand and gravel ---	356	255	--	1	--	3.07
Stone -----	319	289	--	1	--	--
Total ³ -----	4,144	6,811	3	168	.44	24.66

¹ All data are final.

² Only injuries with matching man-hours are included in injury-frequency rate computations.

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

Source: Mine Safety and Health Administration, Department of Labor.

ground metal mines and one was at non-metal surface operations. Frequency rates for fatal and nonfatal injuries decreased

by 56% and 31%, respectively. Nondisabling injuries had a corresponding frequency rate of 9.84.

REVIEW BY MINERAL COMMODITIES

METALS

Antimony.—Production declined drastically because of the lengthy strike at the Sunshine mine, Shoshone County, the State's only producer. Idaho production represented nearly 50% of the U.S. total.

Cadmium.—The State's output came solely from Bunker Hill's metal processing facility in Shoshone County, as a byproduct of zinc smelting. Compared with that of 1975, output increased almost 200% while value rose more than 250%.

Cobalt.—No cobalt was produced in the State; however, exploration continued by Hanna Mining Co. at the Blackbird mine, Lemhi County. Another property with cobalt potential was undergoing evaluation.

Copper.—Production from 22 mines increased 5% to 3,362 short tons; value increased 14% to nearly \$5 million. Two mines in the State produced at over \$1 million worth of copper. Twelve operations in the Coeur d'Alene district, led by the Galena, produced 71% of the State total; most of the remainder came from the Copper Cliff mine in Adams County.

Table 7.—Idaho: Mine production of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery, in terms of recoverable metal

Type of material processed and method of recovery	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Smelting of concentrates -----	2,643	11,554	3,361	53,609	46,582
Direct smelting of ore and amalgamation ¹ -----	112	7	1	7	3
Total -----	2,755	11,561	3,362	53,636	² 46,586

¹ Combined to avoid disclosing company proprietary data.

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

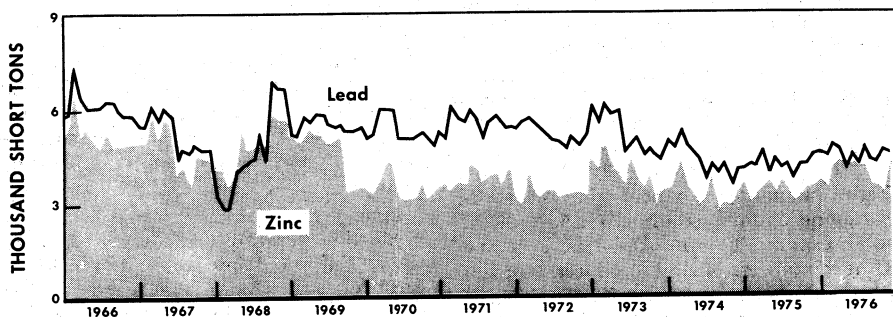


Figure 2.—Mine production of lead and zinc in Idaho, by month, in terms of recoverable metals.

Gold.—Production of 2,755 ounces, up 9% from that of 1975, was from 28 lode mines; no placer production was reported in 1976. Approximately 93% of the production came from the Coeur d'Alene mining district where the Lucky Friday continued to be the largest producer in the State.

Lead.—Idaho continued to rank second nationally in lead production with nearly 54,000 short tons or 9% of the total U.S. quantity. Output rose 6% while value increased 14%. Shoshone County, led by The Bunker Hill Co. (Bunker Hill and 70% of the Star mine) and Hecla Mining Co. (Lucky Friday and 30% of the Star mine), accounted for 98% of the State's total. Minor amounts of lead were mined in Custer (Clayton Silver) and Lemhi Counties.

Silver.—Silver production decreased 17% in 1976 as a result of the strike at the Sunshine mine, which began in March and lasted through the end of the year. The

State still maintained its position as the number one silver producer and accounted for 34% of the Nation's primary silver production. Shoshone County's 11 mines accounted for 98% of the total State production; 5 mines, led by ASARCO's Galena Unit, produced over 1 million ounces each. The Coeur mine, in its first year of operation, surpassed 1 million ounces to become the third leading producer in the State. Outside of Shoshone County, only the Clayton mine, Custer County, and the Copper Cliff mine, Adams County, produced over 50,000 ounces. Construction at the DeLamar Silver mine proceeded on schedule in preparation for 1977 production; the mine will be rated at 2.0 million ounces annually.

Tungsten.—Production was recorded in Valley County. The amount of concentrates shipped quadrupled while the value received increased 19 times over that reported in 1975.

Uranium.—No uranium production was reported for the year. Preliminary exploration by numerous companies was ongoing in the northern part of the State in Bonner and Boundary Counties. The Energy Research and Development Administration (ERDA), through its National Uranium Resource Evaluation (NURE) program, conducted preliminary studies on uranium occurrences in Valley County.

Vanadium.—Production of contained vanadium rose by 15% while the value increased in excess of 42%. The vanadium occurs in ferrophosphorus slag from the phosphate operations in southeastern Idaho. About 55% of the slag was treated at the Kerr-McGee plant at Soda Springs and the remainder was shipped to Union Carbide Corp.'s Hot Springs, Ark., facility. Idaho ranked third in the Nation in vanadium production in both quantity and value.

Zinc.—Output and value for zinc produced increased 14% and 8%, respectively. Eighteen mines produced; 10 mines in Shoshone County accounted for 96% of the total output. The Bunker Hill and Star Unit mines were leading producers. Outside of Shoshone County, only the Hoodoo and Clayton mines in Custer County had notable production.

NONMETALS

Abrasives (Natural).—Production of natural abrasives in Idaho was limited to garnets; all production came from two operations in Benewah County. The two operators, Emerald Creek Garnet Milling Co. and Idaho Garnet Abrasive Co., increased production by 24%; value increased by over 37%.

Barite.—Rocky Mountain Refractories was the only producer in 1976. Output from their Deer Park mine, Blaine County, fell 30% from that of 1975; value received was down 24%.

Cement.—Idaho's only producer, the Idaho Portland Cement Co., in Bannock County, increased production of portland cement by 22% while value increased by 45%. Masonry cement production remained constant but its value increased by 53%. Stocks on hand at yearend were lower when compared with that of the previous year.

Clays.—The production and value of clays produced in the State dropped 31% compared with that of 1975. Almost 60%

came from Latah County, most of which was kaolin. Clay was also produced in Benewah and Elmore Counties. A small quantity of bentonite was also produced.

Fluorspar.—There was no reported fluorspar production in 1976. Domestic Power Development Co. of Idaho Falls was preparing to move a 70-ton mill from Meyers Cove to near Challis in anticipation of mining and milling ore from the Mill Creek-Gordon Creek fluorspar deposit.

Gem Stones.—Gem stone production was valued at \$126,000, a slight increase over that of 1975. Opals (Clark County), star garnets (Benewah County), and fire opals and jasper (Owyhee County) were the most sought after materials.

Gypsum.—Output by the only producer, E. J. Wilson & Sons from the Lidy Hot Springs deposit in Lemhi County, decreased. The value per ton rose and the production was used only for agricultural purposes.

Lime.—Two producers reported lime production in 1976—Amalgamated Sugar Co. in Canyon, Minidoka, and Twin Falls Counties and Utah-Idaho Sugar Co. in Bonneville County. Total production rose by 21% while value increased by 35% compared with that of 1975. The lime was utilized primarily in sugar beet processing.

Perlite.—Oneida Perlite Corp., Oneida County, was the State's single producer of perlite in 1975. Production increased by 20% while the value rose by 57%. Half of the production was used to make expanded perlite, whose value increased significantly above that of 1975. The expanded perlite was used primarily for horticulture and agriculture aggregates and firewall insulation.

Phosphate Rock.—Total marketable production of phosphate rock increased 6% over that of 1975, while the reported value decreased 35%. The decline in value can be directly attributed to the decrease in domestic and world demands. A total of five mines reported production, all surface operations; one was in Bingham County and the others were in Caribou County. J. R. Simplot Co. was the largest producer at 2.6 million tons of marketable rock. The primary use was for elemental phosphorus, with process phosphorus acid production second.

The final EIS on the expansion of the phosphate operations in southeastern Idaho

has not been completed; a moratorium on further leases remained in effect.

Pumice.—Production of pumiceous material fell in 1976 while the value increased. Over 50% of the production came from Bonneville County with the remainder from Oneida and Bingham Counties. The largest producers were Producers Pumice and Hess Pumice Products. Over 85% of the material was used as concrete aggregate;

road construction and abrasives accounted for the remainder.

Sand and Gravel.—Production and value declined somewhat when compared with that of 1975. Ada County produced over 1 million short tons from nine quarries. Canyon, Bonneville, and Kootenai Counties produced over 500,000 short tons each. A total of 97 mines had production.

Table 8.—Idaho: Sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thou- sands)	Value per ton
Construction:			
Sand -----	2,367	\$2,992	\$1.26
Gravel -----	4,182	8,514	2.04
Total -----	6,549	¹ 11,504	1.76
Industrial sand -----	W	W	W

W Withheld to avoid disclosing company proprietary data.

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

Table 9.—Idaho: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thou- sands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	1,977	\$4,797	\$2.43
Concrete products (cement blocks, bricks, pipe, etc.) -----	212	489	2.31
Asphaltic concrete aggregates and other bituminous mixtures	636	1,155	1.82
Roadbase and coverings -----	2,675	3,777	1.41
Fill -----	999	1,195	1.20
Other uses -----	51	93	1.82
Total ¹ -----	6,549	11,504	1.76

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

Stone.—Stone was produced at 77 quarries by 22 companies; the leading producers were the U.S. Forest Service, Deatley Corp., and the Idaho Highway Department. Output and value, when compared with that in 1975, rose. Production from Idaho County exceeded 600,000 tons, while Ban-
nock, Clearwater, and Caribou Counties

had production that exceeded 250,000 tons. The majority of stone production was used for surface treatment aggregate, roadbase aggregate, riprap, cement manufacture, flux stone, and fill.

A small quantity of dimension stone was quarried by Northern Stone Supply and Idaho Travertine Corp.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
METALS			
Antimony: Sunshine Mining Co.	Kellogg, Idaho 83837	Mine and plant	Shoshone.
Copper:			
ASARCO Inc	Wallace, Idaho 83873	Mine and mill	Do.
Hecla Mining Co	do	do	Do.
Gold:			
ASARCO Inc	do	do	Do.
Hecla Mining Co	do	do	Do.
Lead:			
The Bunker Hill Co	Kellogg, Idaho 83837	Mine and plant	Do.
Hecla Mining Co	do	do	Do.
Silver:			
ASARCO Inc	Wallace, Idaho 83873	Mine and mill	Do.
Hecla Mining Co	do	do	Do.
Vanadium: Kerr-McGee Corp	Soda Springs, Idaho 83276	Mine	Caribou.
Zinc:			
The Bunker Hill Co	Kellogg, Idaho 83837	Mine and plant	Shoshone.
Hecla Mining Co	Wallace, Idaho 83873	Mine and mill	Do.
NONMETALS			
Abrasives (natural):			
Emerald Creek Garnet Milling Co.	Fernwood, Idaho 83830	Mine and plant	Benewah.
Idaho Garnet Abrasive Co	Kellogg, Idaho 83837	do	Do.
Barite: Rocky Mountain Refractories.	Hailey, Idaho 83333	Pit	Blaine.
Cement: Idaho Portland Cement Co.	Inkom, Idaho 83245	Plant	Bannock.
Clays:			
Interpace Corp	Lone, Calif. 95640	Pit and plant	Latah.
J. R. Simplot Co	Pocatello, Idaho 83201	Pit	Do.
Gypsum: E. J. Wilson & Sons	Dubois, Idaho 83423	Pit	Lemhi.
Lime:			
Amalgamated Sugar Co	First Security Bank Ogden, Utah 84401	Plants	Canyon, Minidoka, Twin Falls.
Utah-Idaho Sugar Co	Box 1855 Idaho Falls, Idaho 83410	Plant	Booneville.
Perlite: Oneida Perlite Corp	Malad City, Idaho 83252	Pit and plant	Oneida.
Phosphate rock:			
Baker Industries	Box 37, Conda, Idaho 83230	Pit	Caribou.
J. R. Simplot Co	Pocatello, Idaho 83201	Mine	Bingham.
Pumice:			
Hess Pumice Products	Malad City, Idaho 83252	do	Oneida.
Producers Pumice	Ammon, Idaho 83401	Mine	Bonneville.
Sand and gravel:			
J. K. Merrill & Son	Box 106 Spokane, Wash. 99210	Pit	Bannock.
Morrison-Knudsen Co., Inc.	Box 7808 Boise, Idaho 83707	Pit	Ada.
Stone:			
Destley Corp	Box 648 Lewiston, Idaho 83501	Quarry	Bonner.

The Mineral Industry of Illinois

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

By Thomas O. Glover ¹ and Irma Samson ²

The value of mineral production in Illinois in 1976, \$1,581.2 million, increased 6.1% above the record \$1,490.6 million of 1975. Mineral fuels continued to account for the major part of the total mineral value; nonmetals comprise 21.6%; and metals accounted for the remainder. Illinois led in the production of fluorspar, tripoli, and expanded perlite; ranked second in output of stone; and ranked fourth in the production of peat and coal. Coal remained the leading commodity in value, accounting for \$926.0 million, or 58.6% of the State total.

Output of bituminous coal in 1976 was 58.2 million tons, a decrease of 2.2% in quantity from that of 1975; total value of coal production increased 6.3%. Production of crude petroleum was 26.3 million barrels, 0.2 million barrels more than in 1975, valued at \$267.5 million, 16.9% of the total value of mineral output of the State. Marketed production of natural gas increased 8.1% in quantity and 52.1% in value. Production of liquefied petroleum gases de-

creased 3.5% in quantity but increased 13.6% in value; natural gasoline production decreased 9.2% while value increased 3.4%. Production of peat, as measured by sales, decreased in quantity and in value.

Among the nonmetallic mineral commodities, stone ranked first in value followed by sand and gravel and cement. Combined output of sand and gravel and stone accounted for 14.5% of the State's total mineral value in 1976. Illinois supplied about 76% of the total domestic output of fluorspar. Other nonmetallic minerals and mineral products produced in Illinois were barite, clays, gem stones, lime, and tripoli.

Production of lead and zinc declined in 1976 compared with 1975 production. In addition to lead and zinc, a small quantity of silver was also recovered.

In 1976, Illinois ranked 12th in value of mineral production among the States.

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² Research assistant, Mineral Economics, Illinois State Geological Survey.

Table 1.—Mineral production in Illinois¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland ----- thousand short tons	1,374	\$42,756	1,632	\$53,524
Clays ² ----- do	1,366	3,249	1,309	3,272
Coal (bituminous) ----- do	59,537	871,377	58,239	925,968
Fluorspar ----- short tons	99,898	8,957	142,666	14,563
Gem stones ----- NA	NA	2	NA	2
Natural gas ----- million cubic feet	1,440	1,008	1,556	1,533
Peat ----- thousand short tons	96	1,511	87	763
Petroleum (crude) ----- thousand 42-gallon barrels	26,067	273,182	26,272	267,449
Sand and gravel ----- thousand short tons	39,000	83,515	38,784	87,152
Stone ----- do	60,640	130,104	61,862	141,543
Value of items that cannot be disclosed:				
Barite, cement (masonry), clays (fuller's earth), lead, lime, natural gas liquids, silver, tripoli, and zinc -----	XX	74,937	XX	85,396
Total -----	XX	1,490,598	XX	1,581,165
Total 1967 constant dollars -----	XX	589,830	XX	^P 568,429

^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 fuller's earth; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Illinois, by county^{1,2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams -----	W	W	Stone, sand and gravel, petroleum.
Alexander -----	W	W	Tripoli.
Bond -----	\$640	\$822	Petroleum, natural gas, clays, sand and gravel.
Boone -----	W	W	Stone, sand and gravel.
Brown -----	W	W	Stone, petroleum, clays.
Bureau -----	946	1,124	Sand and gravel.
Calhoun -----	52	W	Stone.
Carroll -----	657	559	Do.
Cass -----	11	--	
Champaign -----	1,582	943	Sand and gravel.
Christian -----	W	W	Coal, petroleum, stone.
Clark ³ -----	W	W	Petroleum, stone, sand and gravel.
Clay -----	W	W	Do.
Clinton -----	W	W	Do.
Coles -----	4,531	5,086	Petroleum, stone, natural gas, sand and gravel.
Cook -----	57,228	64,387	Lime, stone, sand and gravel, clays, peat.
Crawford -----	W	W	Petroleum, sand and gravel.
Cumberland ³ -----	W	W	Sand and gravel.
De Kalb -----	W	W	Stone, sand and gravel.
De Witt -----	W	W	Petroleum.
Douglas -----	74,680	85,648	Coal, natural gas liquids, stone, petroleum.
Du Page -----	W	W	Sand and gravel, stone.
Edgar -----	W	W	Petroleum.
Edwards -----	W	W	Do.
Effingham -----	W	W	Petroleum, sand and gravel.
Fayette -----	W	25,840	Petroleum, stone, clays, sand and gravel.
Ford -----	W	W	Sand and gravel.
Franklin -----	W	W	Coal, petroleum.
Fulton -----	42,580	44,879	Coal, sand and gravel.
Gallatin -----	36,178	36,618	Coal, petroleum, sand and gravel, natural gas.
Greene -----	805	W	Stone.
Grundy -----	W	W	Sand and gravel, clays.
Hamilton -----	W	W	Petroleum.
Hancock -----	1,151	682	Stone.
Hardin -----	17,715	22,003	Fluorspar, stone, zinc, barite, lead, silver.
Henderson -----	1,196	W	Stone.
Henry -----	W	W	Do.
Iroquois -----	W	W	Do.
Jackson -----	W	W	Coal, stone, petroleum, sand and gravel.
Jasper -----	W	W	Petroleum.
Jefferson -----	W	W	Coal, petroleum.

See footnotes at end of table.

Table 2.—Value of mineral production in Illinois, by county^{1 2}—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Jersey	\$257	W	Stone.
Jo Daviess	W	\$1,415	Sand and gravel, stone.
Johnson	W	W	Stone.
Kane	\$9,260	W	Sand and gravel, stone, peat.
Kankakee	W	W	Stone, clays, sand and gravel.
Kendall	W	W	Stone, sand and gravel.
Knox	W	W	Coal, stone.
Lake	W	W	Sand and gravel, peat.
La Salle	W	W	Sand and gravel, cement, stone, clays.
Lawrence	W	W	Petroleum, sand and gravel.
Lee	W	W	Cement, stone, sand and gravel.
Livingston	5,614	W	Stone, clays.
Logan	W	W	Sand and gravel, stone.
McDonough	W	W	Stone, petroleum, clays.
McHenry	8,691	7,592	Sand and gravel.
McLean	2,518	2,111	Do.
Macon	W	W	Sand and gravel, petroleum.
Macoupin	W	W	Coal, stone, petroleum.
Madison	W	W	Stone, petroleum, sand and gravel.
Marion	W	W	Petroleum, stone, sand and gravel.
Marshall	—	W	Sand and gravel.
Mason	35	W	Do.
Massac	W	W	Cement, sand and gravel.
Menard	2,739	W	Stone.
Mercer	W	W	Do.
Monroe	W	W	Stone, petroleum.
Montgomery	W	W	Coal, stone, petroleum.
Moultrie	W	W	Petroleum, sand and gravel.
Ogle	W	W	Stone, sand and gravel.
Peoria	W	W	Coal, stone, sand and gravel.
Perry	W	W	Coal, petroleum.
Piatt	W	W	Sand and gravel.
Pike	W	W	Stone, sand and gravel.
Pope	2	—	—
Pulaski	W	W	Clays, stone, sand and gravel.
Randolph	W	W	Coal, stone, petroleum, sand and gravel.
Richland	W	W	Petroleum.
Rock Island	W	W	Stone, sand and gravel.
St. Clair	W	W	Coal, stone, petroleum, sand and gravel.
Saline	W	W	Coal, petroleum, natural gas.
Sangamon	W	W	Sand and gravel, petroleum.
Schuyler	W	W	Sand and gravel.
Scott	W	W	Stone, clays.
Shelby	W	W	Petroleum, sand and gravel, stone.
Stark	W	W	Coal, sand and gravel.
Stephenson	681	620	Stone, sand and gravel.
Tazewell	W	3,134	Sand and gravel, clays.
Union	W	W	Stone, sand and gravel.
Vermilion	W	W	Stone, coal, sand and gravel.
Wabash	W	W	Coal, petroleum, sand and gravel.
Warren	W	W	Stone.
Washington	W	W	Petroleum, stone.
Wayne	W	W	Petroleum.
White	W	W	Petroleum, sand and gravel.
Whiteside	W	W	Stone, peat, sand and gravel.
Will	13,764	14,471	Stone, sand and gravel.
Williamson	69,016	43,157	Coal, petroleum, natural gas.
Winnebago	3,325	2,655	Stone, sand and gravel.
Woodford	2,391	2,978	Sand and gravel.
Undistributed ⁴	1,132,349	1,214,448	—
Total ⁵	1,490,598	1,581,165	—

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

¹ Morgan and Putnam Counties are not listed because no production was reported.

² Value of petroleum is based on an average price per barrel for the State.

³ Value of petroleum production in Cumberland County is included with Clark County because actual source of production cannot be identified.

⁴ Includes some gem stones, stone, and petroleum that cannot be assigned to specific counties, and values indicated by symbol W.

⁵ Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Illinois business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands..	4,997.0	5,076.0	+1.6
Unemployment ----- do.....	355.0	332.0	-6.5
Employment (nonagricultural):			
Mining ----- do.....	25.9	25.9	--
Manufacturing ----- do.....	1,199.8	1,198.5	-.1
Contract construction ----- do.....	172.3	175.3	+1.7
Transportation and public utilities ----- do.....	272.6	274.5	+.7
Wholesale and retail trade ----- do.....	999.0	1,033.2	+3.4
Finance, insurance, real estate ----- do.....	254.7	257.3	+1.0
Services ----- do.....	780.0	804.2	+3.1
Government ----- do.....	714.5	715.0	+.1
Total nonagricultural employment ----- do.....	¹ 4,418.9	¹ 4,483.8	+1.5
Personal income:			
Total ----- millions..	\$75,798	\$82,508	+8.8
Per capita ----- do.....	\$6,769	\$7,347	+8.5
Construction activity:			
Number of private and public residential units authorized..	39,325	59,503	+51.3
Value of nonresidential construction ----- millions..	\$933.9	\$874.5	-6.4
Value of State road contract awards ----- do.....	\$335.2	\$330.0	-1.6
Shipments of portland and masonry cement to and within the State ----- thousand short tons..	3,382	3,877	+14.6
Mineral production value:			
Total crude mineral value ----- millions..	\$1,490.6	\$1,581.2	+6.1
Value per capita, resident population ----- do.....	\$133	\$141	+6.0
Value per square mile ----- do.....	\$26,429	\$28,085	+6.1

^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.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Illinois continued to rank fourth in the Nation in the production of bituminous coal with an output of 58.2 million tons valued at \$926.0 million, which represented a decrease in tonnage of 2.2% and an increase in value of 6.3% compared with the 1975 levels. Value of bituminous coal production accounted for 58.6% of the State's total mineral value in 1976. The average value per ton (f.o.b. mine) for Illinois coal continued to rise; in 1976 it was \$15.90 compared with \$14.64 in 1975.

The utility market continued to be the largest consuming sector for Illinois coal. This market has been growing steadily since 1957, and until coal gasification and liquefaction plants are developed, a strong Illinois coal industry will remain heavily dependent on its ability to retain its competitive position in the utility fuel market.

Production in Illinois in 1976, excluding mines producing less than 1,000 short tons annually, was reported from 62 mines, 4 more than were operating in 1975. Major

producing counties in order of decreasing tonnage, were Perry, Randolph, Jefferson, Franklin, Christian, Macoupin, Williamson, Fulton, Douglas, St. Clair, Saline, Gallatin, Wabash, and Montgomery. Underground mine production accounted for 53.2% of the coal produced in the State in 1976, compared with 53.5% in 1975.

Interest in coal in Illinois continued at a very high level. Many companies were actively exploring, leasing, and developing coal properties within the State. These included both large energy industries and small independent operators. Atlantic Richfield Co. planned to develop and operate an underground mine near Albion in Edwards County. The firm estimated minable reserves at 140 million tons in the Harrisburg (No. 5) and Herrin (No. 6) coal seams, with initial production possible by late 1978 or early 1979. Mobil Oil Corp. purchased the assets of the Mt. Olive and Staunton Coal Co. for \$47.5 million and now owns five parcels of land, including mineral rights, in Madison and Macoupin Counties. These lands have a potential for underground development in the Herrin (No. 6)

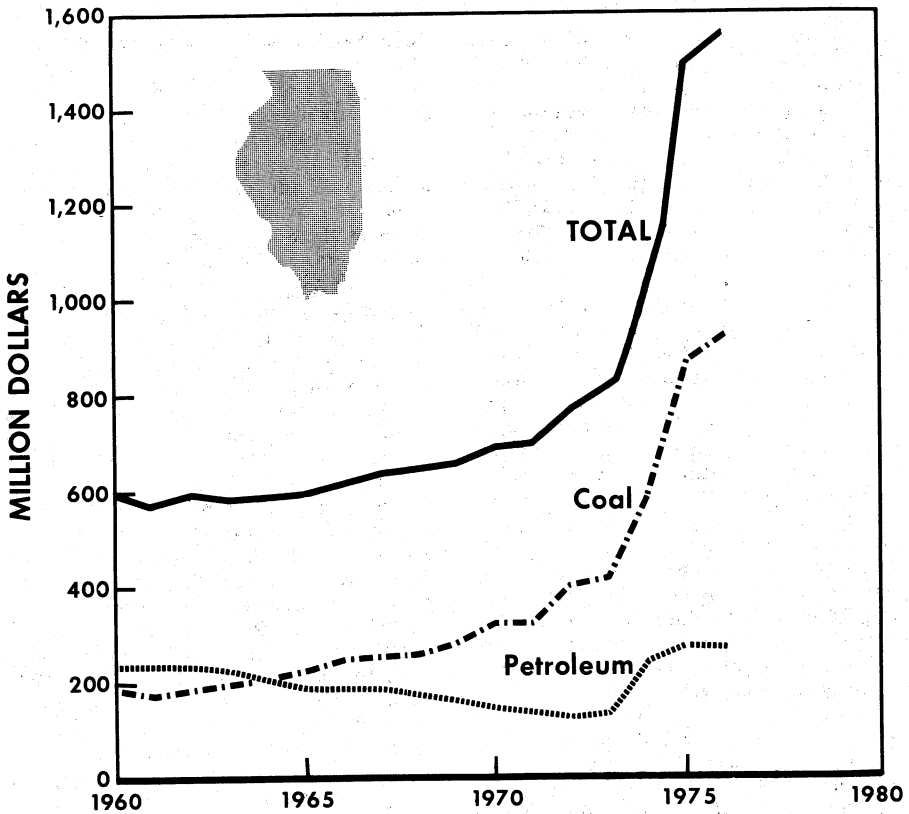


Figure 1.—Value of coal, petroleum, and total value of mineral production in Illinois.

Table 4.—Illinois: Bituminous coal production in 1976, by type of mine and county (Excludes mines producing less than 1,000 short tons annually)

County	Number of mines			Production (thousand short tons)			Value (thousands)
	Under-ground	Strip	Total	Under-ground	Strip	Total	
Christian	1	--	1	W	--	W	W
Douglas	2	--	2	W	--	W	W
Franklin	3	--	3	W	--	W	W
Fulton	--	4	4	--	2,894	2,894	\$44,464
Gallatin	1	1	2	W	W	W	W
Jackson	--	5	5	--	761	761	12,848
Jefferson	3	1	4	W	W	W	W
Knox	--	1	1	--	W	W	W
Macoupin	2	--	2	W	--	W	W
Montgomery	1	--	1	W	--	W	W
Peoria	--	1	1	--	W	W	W
Perry	--	5	5	--	W	W	W
Randolph	3	4	7	W	W	W	W
St. Clair	1	1	2	W	W	W	W
Saline	2	4	6	W	W	W	W
Stark	--	1	1	--	W	W	W
Vermilion	--	1	1	--	W	W	W
Wabash	1	--	1	W	--	W	W
Williamson	3	10	13	W	W	W	W
Total	23	39	62	31,008	27,231	58,239	925,968

W Withheld to avoid disclosing company proprietary data; included in "Total."

coal seam. *MAPCO* is acquiring 20,000 acres of coal leases in White County with an estimated 200 million tons of reserves. Two mines were tentatively planned for 2 million tons each per year. The Tennessee Valley Authority (TVA) has announced its intention to exercise an option to buy coal rights on 39,000 acres of land in southern Illinois. Reserves were estimated at 744 million tons, and the total price for the land will be about \$41 million. An option on 18,000 acres of coal in Spring Garden Township, Jefferson County, has been purchased by the Island Creek Coal Co. Island Creek is a major coal producer in the Eastern United States but does not currently produce coal in Illinois. The Northern Illinois Gas Co. has announced that its coal subsidiary was negotiating with a coal mining company regarding opening a mine in central Illinois.

Commonwealth Research Corp. (a subsidiary of Commonwealth Edison Co.) of Chicago and the Federal Energy Research and Development Administration (ERDA) signed a \$1.8 million contract for the further design of a coal-gasification combined-cycle test facility near Pekin to generate electricity. The final design, construction, and operation of the facility over a 6-year period will cost an estimated \$167 million. ERDA was to provide \$115.6 million of the total funding; the Electric Power Research Institute (Palo Alto, Calif.), \$30 million; Commonwealth Edison, \$14.2 million; and the State of Illinois, Department of Business and Economic Development, \$7.2 million.

ERDA was to provide funds to design an experimental coal gasification plant in Perry County, near Cutler. The plant will be operated by the Illinois Coal Gasification Group (ICGG), which includes Peoples Gas Light and Coke Co., Northern Illinois Gas Co., Central Illinois Light Co., Central Illinois Public Service Co., and North Shore Gas Co. The goal of the project is to use high-sulfur Illinois coal to produce pipeline-quality gas for home and industrial use.

Coke.—Production of coke in 1976 was 1,706,000 tons, a decrease of 11.3% from the 1,924,000 tons produced in 1975. The 1,706,000 tons represented 3% of U.S. production.

Of the 2,722,000 tons of coal received by Illinois's four oven coke plants, 982,000 tons were from Illinois, 960,000 tons from

Kentucky, 638,000 tons from West Virginia, 20,000 tons from Pennsylvania, and 122,000 tons from Virginia. The four oven coke plants carbonized 2,771,000 tons of coal.

About 270,000 tons of coke breeze was recovered at the producing plants, a 7.6% increase over the 251,000 tons recovered in 1975. Other byproducts of coke oven operations in the State included coke oven gas, ammonia, tar, and crude light oil.

Natural Gas.—Marketed production of natural gas in 1976 was 1,556 million cubic feet valued at \$1,533,000, an 8.1% increase over the 1,440 million cubic feet valued at \$1,008,000 of 1975. About 77.0% of the gas was from the Mattoon field in Coles County, and the remainder was from fields in Gallatin, Saline, and Williamson Counties.

According to estimates of the American Gas Association (AGA), proved natural gas reserves in Illinois on December 31, 1976, were 376,876 million cubic feet, compared with 380,804 million cubic feet on December 31, 1975. These reserves included 1,125 million cubic feet of non-associated natural gas wells in Coles, Gallatin, Saline, and Williamson Counties, and 2,508 million cubic feet of natural gas associated with oil production that is either flared or used at the well site. Underground storage in Illinois of natural gas coming from out-of-State accounted for the largest portion of natural gas reserves in Illinois, 373,243 million cubic feet.

Peat.—Illinois produced 84,662 short tons of peat in 1976, 12.1% less than the 96,295 short tons produced in 1975. Production was reported by seven companies from Cook, Kane, Lake, and Whiteside Counties.

Sales totaling 87,087 short tons decreased 9% from the 1975 sales. Humus, moss, and reed-sedge peat were sold in bulk and packaged forms. Of all sales, 88.7% were in packaged forms. The majority of the peat was used for general soil improvement; a small amount was used for potting soils.

Illinois ranked fourth in the Nation in output of peat, accounting for 9% of the Nation's total.

Petroleum.—Petroleum production in Illinois increased 0.8% from 26.1 million barrels in 1975 to 26.3 million barrels in 1976. The value of crude petroleum provided 16.9% of the total State mineral output value.

According to the American Petroleum Institute (API), proved reserves of crude oil in Illinois were 155,318,000 barrels on December 31, 1976, compared with 160,986,000 barrels on December 31, 1975, a decrease of 3.5%.

Petroleum and Natural Gas Exploration and Development.—Total number of well completions in Illinois increased from 956 wells in 1975 to 1,313 wells in 1976. Of the 1,313 wells drilled, 1,066 were proven field wells and 247 were exploratory wells. Of the proven field wells, 719 produced oil, 12 produced gas, and 335 were dry holes. The overall success ratio was 59%. Of the exploratory wells, 16% were completed as oil producers.

Seven new fields, 21 extensions to fields, and 23 new pay zones in fields were discovered in Illinois in 1976.

Drilling for Salem Limestone production continued and is expected to do so for some time; in 1976, 106 wells were completed in the formation in 20 fields in 10 counties. In Keenville field, Wayne County, several Salem wells had initial production figures of more than 300 barrels of oil per day, and at the Clay City Consolidated field, Wayne County, one Salem well had a reported initial production of 500 barrels of oil per day.

In the Main Consolidated field, Crawford County, discovered in 1906, a new deep well encountered oil in the Trenton Formation at a depth of about 4,000 feet, more than 1,000 feet deeper than previous production in the field.

Marathan Oil Co. and ERDA planned to invest a total of \$43.5 million (\$14 million from ERDA) to test Marathon's Maraflooding process, a type of microemulsion chemical flooding. Tests will be conducted at an oilfield in Illinois and, if successful, could open the way for recovery of several hundred million barrels of oil

that cannot be recovered by conventional means. Maraflooding involves injecting detergent chemicals into the oil sand to mobilize crude oil from rock. The detergent is injected as a slug and is followed by injection of polymer-thickened water and plain water in consecutive steps to drive the oil toward a producing well.

Some areas, previously considered marginal or unprofitable for waterflooding, have become profitable because of the increased prices being paid for secondary recovery oil. There is no identified undeveloped acreage in the State that would be considered a prime waterflood prospect, but week-by-week well permits are issued for areas that have never been subjected to waterflood, such as:

1. Salem Consolidated field, Marion County, where Texaco, Inc., found that the Devonian formation would respond to water injection and yield oil at economically desirable rates in spite of a high water-oil production ratio.
2. Lawrence field, Lawrence County, where Marathon Oil Co. has extended waterflood development into many areas that had been previously considered unwaterfloodable because sand conditions were not considered attractive for secondary recovery.
3. Main Consolidated field, Crawford County, where Energy Resources of Indiana held leases in an area east of Hardinville and was developing the area for a marginal Robinson sand waterflood when a basal Pennsylvanian erosional valley was discovered, which became an area of substantial oil activity in late 1976 and early 1977. At least six wells have been completed, with initial production figures ranging from 67 to more than 200 barrels of oil per day. Many permits to drill in this area have been issued, and the search for this type of production can be expected to take place in other areas.

Table 5.—Illinois: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Adams	2	--	4	--	--	1	7	4,704
Bond	6	--	3	1	--	--	10	11,692
Brown	1	--	1	--	--	--	2	2,545
Cass	--	--	--	--	--	1	1	770
Christian	2	--	5	--	--	1	8	16,283
Clark	11	--	2	--	--	6	19	26,505
Clay	89	--	33	2	--	11	135	395,521
Clinton	7	1	5	1	--	8	22	41,423
Coles	8	1	2	--	--	2	13	24,053
Crawford	187	--	18	1	--	1	207	233,424
Cumberland	2	--	2	--	--	2	6	12,633
De Witt	--	--	--	--	--	2	2	3,257
Douglas	1	--	4	1	--	1	7	13,079
Edgar	3	4	4	--	--	7	18	12,834
Edwards	29	--	11	5	--	7	52	157,407
Effingham	5	--	2	--	--	4	11	30,110
Fayette	28	--	6	--	--	4	38	59,816
Franklin	5	--	8	1	--	6	20	66,245
Gallatin	4	--	7	--	--	2	13	35,864
Greene	--	--	--	--	--	1	1	422
Hamilton	2	--	10	2	--	3	17	51,841
Hancock	--	--	--	--	--	2	2	1,415
Henderson	--	--	--	--	--	1	1	1,030
Jackson	--	--	--	--	--	4	4	10,199
Jasper	8	--	3	--	--	--	11	30,331
Jefferson	7	--	8	1	--	2	18	48,231
Lawrence	63	--	17	--	--	8	88	194,085
McDonough	--	--	--	--	--	1	1	750
McLean	--	--	--	--	--	1	1	1,203
Macon	2	--	5	1	--	2	10	21,264
Macoupin	--	--	1	--	--	1	2	950
Madison	2	--	5	--	--	4	11	10,739
Marion	5	--	8	2	--	15	30	82,752
Monroe	1	--	--	--	--	--	1	386
Montgomery	1	--	--	--	--	1	2	830
Morgan	--	--	--	--	--	1	1	825
Moultrie	--	--	--	--	--	2	2	5,217
Perry	1	--	1	--	--	7	9	13,314
Platt	--	--	--	--	--	2	2	4,193
Randolph	1	--	1	--	--	1	3	6,798
Richland	6	--	10	3	--	3	22	69,747
St. Clair	--	6	--	--	--	6	12	11,739
Saline	7	--	4	2	--	7	20	59,100
Sangamon	9	--	9	--	--	6	24	42,834
Schuyler	--	--	1	--	--	--	1	576
Shelby	2	--	--	1	--	4	7	21,997
Vermilion	--	--	--	--	--	1	1	1,464
Wabash	48	--	48	4	--	4	104	228,833
Washington	2	--	7	--	--	10	19	30,802
Wayne	107	--	50	1	--	10	168	581,586
White	51	--	28	8	--	24	111	340,997
Williamson	4	--	2	3	--	5	14	37,599
Total	719	12	335	40	--	207	1,313	3,062,164

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Petroleum Refineries.—In 1976, petroleum refinery crude oil capacity throughout totaled 1,019,000 barrels per calendar day. There were 13 refineries in the State.

Shell Oil Co. has announced that it will build a new acetone manufacturing facility at its Wood River refinery. The plant is scheduled to come onstream in early 1979 and will use Shell's indirect hydration technology to produce isopropyl alcohol which will then be converted to acetone using conventional processing.

NONMETALS

Barite.—Allied Chemical Corp. recovered a primary barite product at its principal mill near Cave in Rock. The barite is associated with the fluor spar deposits at its No. 1 mine. Pfizer, Inc., continued to produce ground barite at its East St. Louis plant in St. Clair County.

Cement.—Portland and masonry cements were produced by four companies in 1976. These were: Marquette Cement

Manufacturing Co. at its Oglesby plant, La Salle County; Medusa Cement Co., a division of Medusa Corp., at its Dixon plant, Lee County; Missouri Portland Cement Co. at its Joppa plant, Massac County; and Centex Corp. at its La Salle plant, La Salle County. Portland cement shipments increased 18.8% in quantity and 25.2% in value; masonry cement shipments increased 7.2% in quantity and 19.1% in value.

Types of portland cement shipped included types I and II (general use and moderate heat), type III (high-early strength), white, waterproof, slag-pozzolan, block, and expansive. Raw materials used in making portland cement included limestone, fly ash, cement rock, clay and shale, sand, gypsum, and slag materials. Disposition of portland cement shipments by type of customer was as follows: Ready-mix concrete companies (67.0%), concrete product manufacturers (6.8%), building material dealers (4.5%), and contractors and other users (21.7%).

Table 6.—Illinois: Portland cement salient statistics
(Short tons)

	1975	1976
Number of active plants	4	4
Production	1,480,628	1,848,575
Shipments from mills:		
Quantity	1,373,960	1,631,812
Value	\$42,755,837	\$53,524,021
Stocks at mills, Dec. 31	155,327	287,246

Clays.—Total production of fire clay and miscellaneous clay and shale decreased 4% in quantity but increased 1% in value in 1976. Production of fuller's earth increased 35% in quantity and 30% in value.

Production of clay and shale was reported from 12 counties. Fire clay was produced by companies in Grundy, McDonough, and Scott Counties.

The brick industry was having trouble filling their orders, and manufacturers of clay sewer pipe were selling all the pipe they could manufacture and changed their production to only pipe that is 8 inches and less in diameter and increased the length of the pipe.

Fluorspar.—Shipments of finished fluorspar totaled 142,666 tons valued at \$14.6 million, increases of 43% in quantity and

63% in value compared with the 1975 figures. The State continued to be the Nation's leading producer of fluorspar, supplying 76% of the output.

Allied Chemical Corp. and Ozark-Mahoning Co., with operations in Hardin County, continued to be the dominant producers. Together they operated about seven exploration and development drilling rigs in Illinois. The discovery and development of new reserves in this district continued to equal the annual production.

Gem Stones.—Small quantities of gem materials and mineral specimens continued to be collected in 1976. Estimated total value of the materials in 1976 remained about \$2,000, the same as the 1975 estimate.

Gypsum.—National Gypsum Co. calcined gypsum at its Waukegan plant in Lake County.

Lime.—Illinois ranked in the top 10 States in the Nation in lime production. Marblehead Lime Co. and Vulcan Materials Co. produced lime at three plants in Cook County for steel furnaces, refractories, water purification, sewage treatment, and other uses. Output increased 12.7% above the 1975 record. The lime was used in Indiana, Illinois, and other destinations.

Perlite.—Crude perlite mined outside the State was expanded by five companies with plants in Cook, De Kalb, Lake, and Will Counties. Sales of the expanded product increased less than 1% in quantity but increased 6% in value. Principal use was for insulation board, which accounted for 70% of the total. Other uses included construction aggregate, filter aid, roof insulation board, and horticultural and agricultural aggregate.

Sand and Gravel.—Production of sand and gravel in 1976 was 38.8 million tons valued at \$87.2 million. Counties from which over a million tons were produced were Du Page, Grundy, Kane, Lake, La Salle, McHenry, Macon, Sangamon, Tazewell, Will, and Woodford.

Of the total sand and gravel produced, 79.6% was used as processed aggregate, 8.8% as unprocessed aggregate, and the remainder as industrial sands and for fill and other uses. The average value of the sand and gravel produced was \$2.25 per ton, compared with \$2.14 per ton in 1975. The State ranked sixth in the Nation in quantity and value of sand and gravel produced.

Sand and gravel production was terminated from a large terrace along Salt Creek

in De Witt County, and the area flooded by the reservoir for the Clinton power station. This was an excellent example of conservation of natural resources by producing material from reserves that would otherwise become unrecoverable.

Stone.—Illinois, with 61.9 million tons, ranked second in the Nation in the pro-

duction of stone. The average value of the total stone produced was \$2.29 per ton in 1976. Major producing counties, each with production of over 1 million short tons, were Cook, Hardin, Johnson, Kane, Kankakee, La Salle, Lee, Livingston, Madison, Montgomery, Rock Island, St. Clair, Union, Vermilion, and Will.

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

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	18,648	\$28,410	\$1.52
Gravel	15,651	33,350	2.13
Total ¹	34,300	61,759	1.80
Industrial sand	4,484	25,393	5.66
Grand total	38,784	87,152	2.25

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

Table 8.—Illinois: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	13,469	\$25,727	\$1.91
Concrete products (cement blocks, bricks, pipe, etc.)	2,613	4,911	1.88
Asphaltic concrete aggregates and other bituminous mixtures ..	6,721	11,677	1.74
Roadbase and coverings	6,443	11,926	1.85
Fill	4,623	6,842	1.48
Other uses	428	677	1.58
Total ¹	34,300	61,759	1.80

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

Crushed stone was produced by 116 companies at 273 quarries for roadbase aggregate, concrete, bituminous aggregate, and other uses. Dimension stone, which represented only a small part of the total stone production in the State, was produced in Kane County.

Trucks transported 87.8% of the crushed and broken stone; the remainder was shipped by railroad and waterway transportation.

During 1976, two small central Illinois

quarries changed hands. Indian Point Limestone Products Co. near Athens in Menard County was sold to Material Service Corp. of Chicago. Rocky Ford Limestone Co. of Lincoln in Logan County was sold to Martin Marietta Aggregates, whose Central Division office is in Peoria.

A dense, white Devonian chert, locally called novaculite in Alexander County, was approved by the Illinois Department of Transportation for use as skid-resistant aggregate in bituminous concrete.

Table 9.—Illinois: Production of crushed limestone, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	18,690	39,742	17,310	38,090
Concrete aggregate	10,309	21,705	10,610	24,250
Bituminous aggregate	6,318	13,299	6,679	15,240
Roadstone	5,486	11,464	6,613	14,240
Agricultural limestone	5,712	12,010	6,613	15,299
Surface treatment aggregate	5,240	11,021	3,927	8,845
Macadam aggregate	2,985	6,237	3,364	7,626
Cement manufacture	2,394	4,069	2,887	5,005
Lime manufacture	877	1,870	858	1,749
Riprap and jetty stone	775	1,647	779	1,776
Railroad ballast	400	765	648	1,323
Other filler	523	3,586	495	3,842
Flux stone	309	623	349	751
Mineral food	W	W	132	1,012
Fill	71	69	106	149
Asphalt filler	75	256	91	350
Other uses ¹	469	1,660	397	1,892
Total ²	60,637	130,020	61,858	141,440

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

¹ Includes stone used for waste material (1975), whiting, glass (1976), mine dusting, chemicals, soil conditioning (1976), filter stone (1976), and uses indicated by symbol W.

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

Table 10.—Illinois: Crushed limestone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975		1976	
	Quantity	Value	Quantity	Value
Adams	980	4,905	895	5,704
Boone	W	W	W	W
Brown	W	W	W	W
Calhoun	21	52	W	W
Carroll	352	657	285	559
Christian	710	1,626	W	W
Clark	W	W	500	1,566
Clay	W	W	W	W
Clinton	W	W	W	W
Coles	493	1,646	486	1,632
Cook	14,973	29,006	14,632	30,062
Cumberland	2	5	W	W
De Kalb	W	W	W	W
Douglas	W	W	W	W
Du Page	W	W	W	W
Effingham	3	7	W	W
Fayette	258	696	265	738
Ford	3	7	W	W
Greene	365	805	371	W
Grundy	(¹)	1	W	W
Hancock	498	1,151	284	682
Hardin	2,273	4,108	2,338	4,471
Henderson	544	1,196	W	W
Henry	W	W	W	W
Iroquois	W	W	W	W
Jackson	W	W	W	W
Jersey	W	W	W	W
Jo Daviess	119	257	W	W
Johnson	392	529	428	579
Kane	W	W	W	W
Kankakee	1,041	2,240	1,176	2,656
Kendall	2,229	4,400	W	W
Knox	W	W	W	W
La Salle	W	W	W	W
Lee	2,083	4,194	2,335	4,697
Livingston	1,409	2,488	1,449	2,575
Logan	2,302	5,263	2,998	7,854
McLean	W	W	W	W
McDonough	6	13	W	W
Macoupin	W	W	W	W
Madison	W	W	W	204
Marion	1,245	3,098	1,412	3,573
Menard	W	W	W	W
Mercer	W	2,739	W	W
Monroe	W	W	W	W
Montgomery	W	W	493	1,342
Moultrie	1,240	3,003	1,394	3,626
Ogle	5	10	W	W
Peoria	613	1,208	629	1,361
Perry	W	W	274	712
Piatt	10	20	W	W
Pike	4	12	W	W
Pope	538	1,144	415	944
Pulaski	(¹)	2	W	W
Randolph	W	W	W	W
Rock Island	542	1,089	W	W
St. Clair	1,325	3,160	1,271	3,078
Saline	1,325	6,637	2,676	5,984
Sangamon	3,229	2	W	W
Scott	1	6	W	W
Shelby	W	W	W	W
Stephenson	W	W	W	W
Union	274	478	282	454
Vermilion	W	W	1,216	2,951
Warren	W	W	W	W
Washington	W	W	W	W
Whiteside	418	1,358	376	1,141
Will	W	W	W	W
Winnebago	5,516	10,372	5,618	11,293
Undistributed	884	1,588	770	1,779
	13,732	28,847	16,592	39,228
Total ²	60,637	130,020	61,858	141,440

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

¹ Less than ½ unit.

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

Sulfur (Recovered Elemental).—Sulfur was recovered by Shell Oil Co. at its Hartford refinery, Madison County; by Union Oil Co. of California, Union 76 Div., in Cook County; by Marathon Oil Co. at its Robinson refinery, Crawford County; by Mobil Oil Corp. at its refinery near Joliet in Will County; by Texaco, Inc., at its Lockport plant, Will County, and Lawrenceville plant, Lawrence County; by Natural Gas Pipeline Co. of America, St. Elmo pipeline, Fayette County; and by Natural Gas Pipeline Co. of America, Herscher Pipeline Storage Div., Kankakee County. Nationally, Illinois ranked sixth in quantity and seventh in value of recovered elemental sulfur.

Tripoli (Amorphous Silica).—Crude material was recovered from underground mines in Alexander County by Illinois Minerals Co. near Elco and by Tammsco, Inc., near Tamms. The production of crude material increased 31.1% in quantity and 20.8% in value. Output of prepared material increased 38% in quantity and 42% in value. Prepared material was used for abrasives, filler, and other purposes. Of the few States that produce tripoli in the United States, Illinois continued to rank first in production.

Vermiculite.—Crude vermiculite mined outside the State was processed by W. R. Grace & Co. at its West Chicago plant, Du Page County; by Mica Pellets, Inc., at its plant in De Kalb County; and by Inter-

national Vermiculite Co. at its plant in Macoupin County. Uses were for insulation, aggregate in plaster and concrete, horticulture, fertilizer carrier, and other purposes.

METALS

Iron Oxide Pigments.—In 1976, four plants in Adams, Kane, Sangamon, and St. Clair Counties, produced finished (natural and manufactured) iron oxide pigments. Illinois ranked first in the production of finished iron oxide pigments in 1976. Output for the State in 1976 (as indicated by sales) increased in quantity and in value over that of 1975.

Iron and Steel.—About 6.4 million tons of pig iron valued at \$1,119.8 million was shipped from Illinois blast furnaces or was consumed by the producing companies, compared with 5.2 million tons valued at \$905.5 million in 1975. Pig iron was produced by five companies.

According to the American Iron and Steel Institute, Illinois produced 11.3 million short tons of steel in 1976, compared with 9.6 million short tons in 1975. Nationally, Illinois ranked fourth in the production of raw steel in 1976.

Lead and Zinc.—Production of lead and zinc decreased in 1976.

Other Metals.—Smelter production of cadmium in Illinois in 1976 increased 848% in quantity and 489% in value.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Barite: Pfizer, Inc., Minerals, Pigments & Metals Div.	2001 Lynch Ave. East St. Louis, Ill. 62201	Grinding plant	St. Clair.
Cement:			
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Portland and masonry, dry process.	La Salle.
Medusa Cement Co., a division of Medusa Corp.	Box 5668 Cleveland, Ohio 44101	do	Lee.
Missouri Portland Cement Co.	7751 Carondelet Ave. St. Louis, Mo. 63105	do	Massac.
Clays:			
American Brick Co	6558 West Fullerton Ave. Chicago, Ill. 60635	Pit and plant	Cook.
A. P. Green Refractories Co., a division of United States Gypsum Co.	Box 64 Morris, Ill. 60450	do	Grundy.
Illinois Brick Co., a division of Old Fort Industries, Inc.	228 North La Salle St. Chicago, Ill. 60450	do	Cook.
Marblehead Lime Co., subsidiary of General Dynamics Corp.	300 West Washington St. Chicago, Ill. 60606	do	La Salle.
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Pit	Do.
Richards Brick Co	234 Springer Ave. Edwardsville, Ill. 62025	Pit	Bond.
Southern Clay Co., Inc., subsidiary of Lowe's, Inc.	North Edward St. Cassopolis, Mich. 49031	Pit and plant	Pulaski.
Streator Brick Systems, Inc.	West End of Ninth St. Streator, Ill. 61364	Pits	La Salle and Livingston.
Western Brick Co., a division of Illinois Brick Co.	Box 591 Danville, Ill. 61832	Pit and plant	Vermilion.
Coal, bituminous:			
Amax Coal Co., a division of American Metal Climax, Inc.:	105 South Meridian St. Indianapolis, Ind. 46225		
Sun Spot		Strip mine, cleaning plant.	Fulton.
Leahy		do	Perry.
Delta		do	Williamson.
Wabash		Underground mine.	Wabash.
Consolidation Coal Co., Midwestern Div.:	Box 218 Pinckneyville, Ill. 62274		
Hillsboro		do	Montgomery.
Norris		Strip mine, cleaning plant.	Fulton.
Burning Star No. 2		do	Perry.
Burning Star No. 3		do	Randolph.
Burning Star No. 4		do	Perry.
Burning Star No. 5		Strip mine	Do.
Eads Coal Co	Box 1473 St. Louis, Mo. 63178	do	Jefferson.
Freeman United Coal Mining Corp.:	300 West Washington Ave. Chicago, Ill. 60606		
Orient No. 3		Underground mine, cleaning plant.	Do.
Orient No. 6		do	Do.
Orient No. 4		do	Williamson.
Crown II Mine		do	Macoupin.
Buckheart No. 17		Strip mine, cleaning plant.	Fulton.
Fidelity No. 11		do	Perry.
Inland Steel Co.:	30 West Monroe St. Chicago, Ill. 60603		
Inland		Underground mine, cleaning plant.	Jefferson.
Midland Coal Co., a division of American Smelting and Refining Co.:	Box 8 Trivoli, Ill. 61569		
Allendale		Strip mine, cleaning plant.	Stark.
Mecco		do	Knox.
Elm Pit		do	Peoria.
Rapatee		do	Fulton.
Monterey Coal Co	205 Oakland Ave. Carlinville, Ill. 62626	Underground mine, cleaning plant.	Macoupin.
Old Ben Coal Co.:	10 South Riverside Plaza Chicago, Ill. 60606		
Old Ben No. 21		do	Franklin.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Coal, bituminous—Continued			
Old Ben Coal Co.—Continued			
Old Ben No. 24 -----	-----	Underground mine.	Franklin.
Old Ben No. 26 -----	-----	Underground mine, cleaning plant.	Do.
Peabody Coal Co.:	301 North Memorial Dr. St. Louis, Mo. 63102		
No. 10 -----	-----	do -----	Christian.
Eagle -----	-----	Strip and under- ground mines, cleaning plant.	Gallatin.
Baldwin No. 1 -----	-----	Underground mine, cleaning plant.	Randolph.
River King -----	-----	Strip and under- ground mines, cleaning plant.	St. Clair.
Will Scarlet -----	-----	Strip mine, clean- ing plant.	Williamson.
Sahara Coal Co., Inc.:	59 East Van Buren St. Chicago, Ill. 60605		
No. 6 -----	-----	do -----	Saline.
No. 20 -----	-----	Underground mine.	Do.
No. 21 -----	-----	do -----	Do.
Southwestern Illinois Coal Corp.:	Box 14743 St. Louis, Mo. 63178		
Captain -----	-----	Strip mine, clean- ing plant.	Perry.
Streamline -----	-----	do -----	Randolph.
Zeigler Coal Co.:	Box 66913 A.M.F. O'Hare, Ill. 60666		
Murdock -----	-----	Underground mine, cleaning plant.	Douglas.
Spartan No. 2 -----	-----	do -----	Randolph.
Zeigler No. 4 -----	-----	do -----	Williamson.
Zeigler No. 5 -----	-----	Underground mine.	Douglas.
Zeigler No. 11 -----	-----	Underground mine, cleaning plant.	Randolph.
Coke:			
Interlake, Inc -----	310 South Michigan Ave. Chicago, Ill. 60604	Coke ovens -----	Cook.
National Steel Corp., Granite City Steel Div.	Box 367 Granite City, Ill. 62040	do -----	Madison.
Republic Steel Corp -----	Box 6778 Cleveland, Ohio 44101	do -----	Cook.
Wisconsin Steel Div. of Envirodyne.	410 North Michigan Ave. Chicago, Ill. 60611	do -----	Do.
Fluorspar:			
Allied Chemical Corp.:	Lambstown Rd. Cave in Rock, Ill. 62919		
Crystal Group -----	-----	Underground mines, mill.	Hardin.
Minerva No. 1 -----	-----	Underground mine, mill.	Do.
Ozark-Mahoning Co -----	Box 57 Rosiclare, Ill. 62982	Underground mines, mill.	Do.
Iron and steel:			
Interlake, Inc -----	310 South Michigan Ave. Chicago, Ill. 60604	Iron furnaces -----	Cook.
National Steel Corp., Granite City Steel Div.	Box 365 Granite City, Ill. 62040	do -----	Madison.
Republic Steel Corp -----	Box 6778 Cleveland, Ohio 44101	Iron furnace and steel furnace.	Cook.
United States Steel Corp --	3426 East 89th St. Chicago, Ill. 60617	do -----	Do.
Wisconsin Steel Div. of Envirodyne.	410 North Michigan Ave. Chicago, Ill. 60611	Iron and steel furnaces.	Do.
Iron oxide pigments, finished:			
George B. Smith Chemical Works.	Maple Park, Ill. 60151	Plant -----	Kane.
Pfizer, Inc., Minerals, Pig- ments & Metals Div.	2001 Lynch Ave. East St. Louis, Ill. 62201	do -----	St. Clair.
Prince Manufacturing Co --	Bowmanstown, Pa. 18030	do -----	Adams.
Lead and zinc:			
Allied Chemical Corp -----	Lambstown Rd. Cave in Rock, Ill. 62919	Underground mines, mill.	Hardin.
Ozark-Mahoning Co -----	Box 57 Rosiclare, Ill. 62982	do -----	Do.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime:			
Marblehead Lime Co.:	300 West Washington St. Chicago, Ill. 60606		
South Chicago Limekiln.	-----	Quicklime and hydrated lime, 4 rotary kilns.	Cook.
Thornton Limekiln	-----	do	Do.
Vulcan Materials Co	Box 6 Countryside, Ill. 60525	Quicklime, 3 rotary kilns.	Do.
Natural gas liquids: U.S. Indus- trial Chemicals Co., a division of National Distillers & Chemical Corp.	99 Park Ave. New York, N.Y. 10016	Plant	Douglas.
Peat:			
Anderson Peat Co	Morrison, Ill. 61270	Bog, processing plant.	Whiteside.
Markman Peat Co	Route 3 Morrison, Ill. 61270	do	Do.
Perlite, expanded:			
Filter Products Corp	124 North Buesching Rd. Lake Zurich, Ill. 60047	Processing plant	Lake.
Johns-Manville Perlite Corp., Building Products Div.	Box 5103 Denver, Colo. 80217	do	Will.
Mica Pellets, Inc	1120 Oak St. De Kalb, Ill. 60115	do	De Kalb.
National Gypsum Co	325 Delaware Ave. Buffalo, N.Y. 14202	do	Lake.
Silbrico Corp	6300 River Rd. La Grange, Ill. 60525	do	Cook.
Petroleum refineries:			
Amoco Oil Co	200 East Randolph Chicago, Ill. 60601	Refinery	Madison.
Clark Oil & Refining Corp.	8530 West National Ave. Milwaukee, Wis. 53227	do	Cook and Madison.
Marathon Oil Co	539 South Main Findlay, Ohio 45840	do	Crawford.
Mobil Oil Corp	Box 874 Joliet, Ill. 60434	do	Will.
Shell Oil Co	One Shell Plaza Houston, Tex. 77002	do	Madison.
Texasco, Inc	135 East 42d St. New York, N.Y. 10017	do	Lawrence and Will.
Union Oil Co. of California.	Box 239 Lemont, Ill. 60439	do	Cook.
Sand and gravel:			
Elmhurst-Chicago Stone Co.	400 West 1st St. Elmhurst, Ill. 61026	Pits, portable and stationary plants.	Du Page, Kane, Will.
General Dynamics Corp	4226 South Lawndale Ave. Lyons, Ill. 60534	Pits, dredges, portable and stationary plants.	Cook, Du Page, Grundy, Kane, McHenry, Will.
McHenry Sand & Gravel Co., Inc.	920 North Front St. McHenry, Ill. 60050	Pits, stationary plants.	McHenry.
Martin Marietta Aggregates.	Box 789 Cedar Rapids, Iowa 52406	Pits, portable and stationary plants.	Ogle, Peoria, Tazewell, Woodford.
Meyer Aggregate	Box 56, Route 2 Algonquin, Ill. 60102	do	Kendall and McHenry.
Moline Consumers Co	313 16th St. Moline, Ill. 61265	Pits, dredges, portable and stationary plants.	La Salle, Pike, Rock Island.
Ottawa Silica Co	Box 577 Ottawa, Ill. 61350	Pits, portable and stationary plants.	La Salle.
Road Materials Corp., E. M. Melahn Construction Co., Inc.	Box 205, Route 63 East Dundee, Ill. 60118	Pits, stationary plants.	Kane and McHenry.
Vulcan Materials Co	Box 391 La Grange, Ill. 60525	Pits, portable and stationary plants.	Kane, Lake, McHenry.
Wedron Silica Co., Del Monte Properties Co.	400 West Higgins Rd. Park Ridge, Ill. 60068	Pit, stationary plant.	La Salle.
Smelters and refineries:			
AMAX Zinc Co., Inc	Box 347 East St. Louis, Ill. 62202	Zinc primary plant.	St. Clair.
American Smelting & Refining Co.	120 Broadway New York, N.Y. 10005	Zinc secondary plant.	Montgomery.
N. L. Industries, Inc	111 Broadway New York, N.Y. 10006	Lead secondary plants.	Cook and Madison.
The Richardson Graphics Co.	1800 South 54th Ave. Chicago, Ill. 60650	do	Cook.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Columbia Quarry Co -----	Box 1000 Dupu, Ill. 62239	Quarries, stationary plants.	Johnson, Massac, Pulaski, St. Clair.
Elmhurst-Chicago Stone Co.	400 West 1st St. Elmhurst, Ill. 61026	Underground mine, stationary plant.	Monroe.
General Dynamics Corp ----	4226 South Lawndale Ave. Lyons, Ill. 60534	Quarry, stationary plant.	Du Page.
		Underground mine, stationary plant.	Adams.
		Quarries, stationary plants.	Cook, Vermilion, Will.
Industrial Chemical, a divi- sion of Allied Chemicals Corp.	Box 70 Morristown, N.J. 07960	----do -----	Randolph.
Marquette Cement Manu- facturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Quarry, stationary plant.	La Salle.
Medusa Cement Co -----	Box 5668 Cleveland, Ohio 44101	Quarries, stationary plants.	Clark, Henderson, Kankakee, Lee.
Mississippi Lime Co -----	7 Alby St., Box 247 Alton, Ill. 62002	Underground mine, stationary plant.	Madison.
Moline Consumers Co -----	313 16th St. Moline, Ill. 61255	Quarries, portable and stationary plants.	Adams, Henry, Pike, Rock Island, Schuyler, Warren.
Rein, Schultz & Dahl, Inc..	6217 Nesbitt Rd. Madison, Wis. 53711	Quarries, portable plants.	Carroll, Stephenson, Winnebago.
Vulcan Materials Co -----	Box 391 La Grange, Ill. 60525	Quarries, stationary plants.	Cook and Will.
Sulfur, recovered:			
Marathon Oil Co -----	Robinson, Ill. 62454 -----	Byproduct sulfur recovery.	Crawford.
Mobil Oil Corp -----	Box 874 Joliet, Ill. 60434	----do -----	Will.
Union Oil Co. of California	Box 239 Lemont, Ill. 60439	----do -----	Cook.
Tripoli, amorphous silica:			
Illinois Minerals Co -----	2035 Washington Cairo, Ill. 62914	Underground mine.	Alexander.
Tammsco, Inc -----	Box J Tamms, Ill. 62988	----do -----	Do.
Vermiculite, exfoliated:			
W. R. Grace & Co., Con- struction Products Div.	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant --	Du Page.
International Vermiculite Co.	1st and Mound Sts. Girard, Ill. 62640	----do -----	Macoupin.
Mica Pellets, Inc -----	1120 Oak St. De Kalb, Ill. 60115	----do -----	De Kalb.

The Mineral Industry of Indiana

This chapter has been prepared under a cooperative agreement 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 minerals except fuels.

By William S. Miska¹

Indiana's mineral output in 1976 was valued at \$607.3 million, \$65.7 million or 12% above the previous year. The value of mineral output has set a new record high each year for 7 consecutive years. In 1976, higher prices, particularly for coal, accounted for much of the increase in value over 1975.

Mineral production value in the State was divided as follows: Coal, 52%; portland and masonry cement, 14%; stone, 12%; petroleum, 8%; sand and gravel, 7%; and all remaining commodities combined, 7%.

Quantity and value of the principal commodities produced in 1976 compared with 1975 were as follows: Coal increased 1% in quantity and 12% in value, portland

and masonry cements increased 14% in quantity and 16% in value, stone decreased 2% in quantity and increased 5% in value, petroleum decreased slightly in quantity and increased 3% in value, and sand and gravel increased 20% in quantity and 29% in value. Clays, gypsum, and lime also each increased in quantity and value. Only natural gas registered a decrease in both categories.

No metallic ores are mined in Indiana; however, large quantities of iron, steel, and aluminum were produced from ores shipped to Indiana plants for smelting and refining.

¹ State Liaison Officer, Bureau of Mines, Bloomington, Ind.

Table 1.—Mineral production in Indiana¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry -----thousand short tons--	343	\$12,263	396	\$14,270
Portland -----do-----	2,185	63,077	2,490	73,432
Clays -----do-----	1,094	1,961	1,265	2,308
Coal (bituminous) -----do-----	25,124	280,130	25,369	312,990
Natural gas -----million cubic feet--	346	135	192	100
Peat -----thousand short tons--	76	1,918	144	1,716
Petroleum (crude) thousand 42-gallon barrels--	4,632	48,821	4,630	50,421
Sand and gravel -----thousand short tons--	21,641	35,234	25,884	45,521
Stone -----do-----	28,947	68,850	28,450	72,205
Value of items that cannot be disclosed:				
Abrasives, gypsum, and lime -----	XX	29,211	XX	34,358
Total -----	XX	541,600	XX	607,321
Total 1967 constant dollars -----	XX	214,311	XX	^p 218,332

^p Preliminary. XX Not applicable.

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

Table 2.—Value of mineral production in Indiana, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 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	Do.
Boone	\$308	\$330	Sand and gravel.
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel, clays.
Clark	W	W	Cement, stone, clays, sand and gravel.
Clay	W	W	Coal, clays.
Clinton	—	W	Sand and gravel.
Crawford	5,633	5,674	Stone.
Daviess	W	W	Coal, sand and gravel.
Dearborn	W	510	Sand and gravel.
Decatur	W	W	Stone.
De Kalb	456	600	Sand and gravel.
Delaware	W	W	Stone, sand and gravel.
Dubois	W	W	Coal, clays.
Elkhart	814	815	Sand and gravel, stone.
Fayette	410	W	Sand and gravel.
Floyd	W	W	Do.
Fountain	W	W	Sand and gravel, coal, clays.
Franklin	W	W	Stone, sand and gravel.
Fulton	W	251	Sand and gravel, peat.
Gibson	—	W	Coal, sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	W	W	Coal, sand and gravel, clays.
Hamilton	5,906	W	Sand and gravel, stone, peat.
Hancock	374	W	Peat, sand and gravel.
Harrison	W	W	Stone, sand and gravel.
Henry	302	1,028	Sand and gravel.
Howard	W	W	Sand and gravel, stone.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	W	W	Sand and gravel, clays.
Jasper	W	W	Stone, sand and gravel, peat.
Jay	W	W	Stone, sand and gravel.
Jennings	W	W	Stone.
Johnson	291	382	Sand and gravel.
Knox	W	W	Coal, sand and gravel.
Kosciusko	457	1,012	Sand and gravel.
Lagrange	W	W	Sand and gravel, stone.
Lake	37,234	43,815	Lime, cement, clays, sand and gravel.
La Porte	W	W	Sand and gravel, peat.
Lawrence	W	W	Cement, stone, clays.
Madison	W	W	Stone, sand and gravel.
Marion	W	W	Sand and gravel, stone.
Marshall	W	W	Sand and gravel, stone, peat.
Martin	W	W	Gypsum.
Miami	W	W	Sand and gravel, stone.
Monroe	8,517	W	Stone.
Montgomery	27	52	Clays, sand and gravel.
Morgan	W	W	Sand and gravel, clays, stone.
Newton	W	1,953	Stone.
Noble	W	370	Sand and gravel, stone.
Ohio	—	W	Sand and gravel.
Orange	W	1,432	Stone, abrasives.
Owen	W	W	Stone, sand and gravel, coal.
Parke	W	W	Sand and gravel, clays.
Perry	W	W	Stone, coal.
Pike	76,943	W	Coal, sand and gravel.
Porter	W	W	Sand and gravel, clays.
Posey	W	W	Sand and gravel.
Pulaski	W	863	Stone, clays.
Putnam	W	W	Cement, stone, clays, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Ripley	W	W	Stone.
Rush	W	W	Stone, sand and gravel.
St. Joseph	1,783	W	Sand and gravel, peat, stone.
Scott	W	W	Stone.
Shelby	W	W	Stone, sand and gravel.
Spencer	5,481	W	Coal, sand and gravel.
Steuben	W	489	Sand and gravel, stone.
Sullivan	W	W	Coal, sand and gravel, stone.
Switzerland	W	W	Sand and gravel, stone.
Tippecanoe	1,973	2,133	Sand and gravel.
Tipton	W	W	Do.
Vanderburgh	—	W	Do.
Vermillion	W	W	Coal, sand and gravel, clays.
Vigo	W	W	Sand and gravel, coal, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Indiana, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Wabash -----	W	W	Stone, sand and gravel.
Warren -----	W	\$2,479	Sand and gravel.
Warrick -----	W	W	Coal.
Washington -----	W	W	Stone.
Wayne -----	\$1,628	1,639	Sand and gravel, stone.
Wells -----	W	W	Stone, peat.
White -----	W	727	Stone.
Whitley -----	W	W	Sand and gravel.
Undistributed ² -----	393,063	540,778	
Total -----	541,600	607,321	

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

¹ The following counties are not listed because no production was reported: Benton, Brown, Hendricks, Jefferson, Starke, and Union.

² Includes petroleum and natural gas production 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 Indiana business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	2,394.0	2,427.0	+1.4
Unemployment ----- do-----	206.0	148.0	-28.2
Employment (nonagricultural):			
Mining ----- do-----	7.7	8.0	+3.9
Manufacturing ----- do-----	647.2	681.8	+5.3
Contract construction ----- do-----	79.7	79.4	-.4
Transportation and public utilities ----- do-----	100.9	101.2	+.3
Wholesale and retail trade ----- do-----	420.2	433.5	+3.2
Finance, insurance, real estate ----- do-----	89.1	90.6	+1.7
Services ----- do-----	273.6	283.2	+3.5
Government ----- do-----	323.3	332.3	+2.8
Total nonagricultural employment ----- do-----	1,941.7	2,010.0	+3.5
Personal income:			
Total ----- millions--	\$29,602	\$32,990	+11.4
Per capita ----- do-----	\$5,572	\$6,222	+11.7
Construction activity:			
Number of private and public residential units authorized ----- do-----	23,096	30,677	+32.8
Value of nonresidential construction ----- millions--	\$309.3	\$346.1	+11.9
Value of State road contract awards ----- do-----	\$130.2	\$137.0	+5.2
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,641	1,816	+10.7
Mineral production value:			
Total crude mineral value ----- millions--	\$541.6	\$607.3	+12.1
Value per capita, resident population ----- do-----	\$102	\$115	+12.7
Value per square mile ----- do-----	\$14,924	\$16,735	+12.1

^p Preliminary.

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

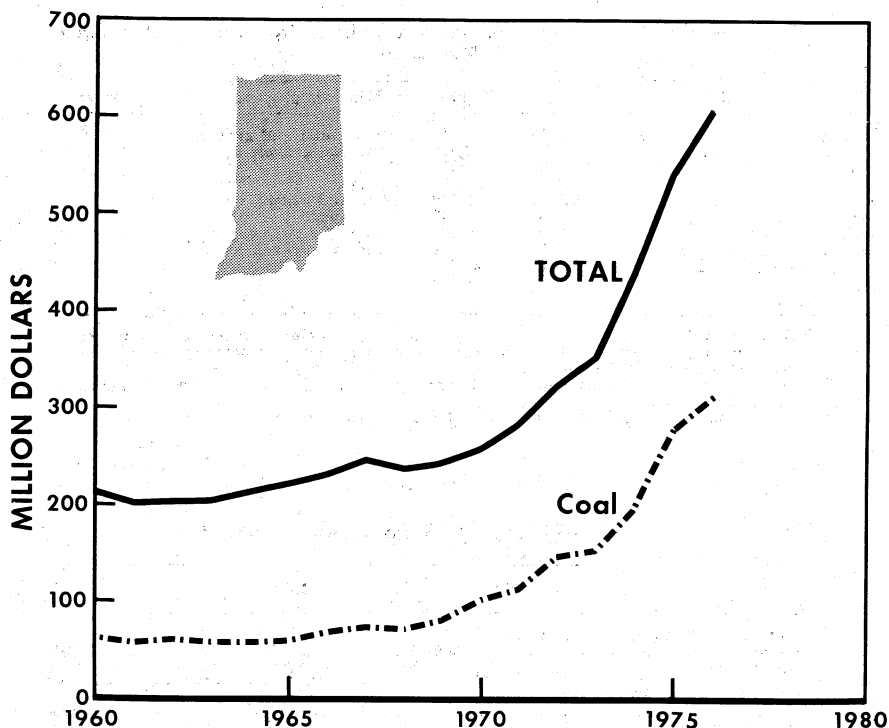


Figure 1.—Value of coal and total value of mineral production in Indiana.

Legislation and Government Programs.—Public Law 152 (House Bill 1305) was enacted during the 1976 session of the Indiana General Assembly. The law directs the Indiana Department of Natural Resources to survey and inventory mined areas of the State and to submit a reclamation plan to the Conservation Advisory Committee by November 1, 1978.

Blasting at strip coal mines in Indiana came under State regulation for the first time on October 15, when the Governor approved rules drafted by the Division of Labor and its Bureau of Mines and Mining. A law passed by the legislature in 1975 called for the controls on blasting. The new rules employ formulas and methods developed by the Federal Bureau of Mines to determine how much explosives miners can use and how to measure blast vibrations. Records on each blast must be retained for 3 years, and no blasting is permitted at night or on Sunday.

The Division of Reclamation, with approval of the Natural Resources Commission, issued 129 surface mining permits for coal, clay, and shale extraction to 66 companies. The acreage under permit totaled 6,382 compared with 6,264 acres in 1975. More than 99% of the acreage was for coal strip mining. The permits issued in 1976 require reclamation of the land for the following uses: 240 acres or 4%, forest land with a maximum grade of 33 $\frac{1}{3}$ %; 2,056 acres or 32%, range land with the same maximum grade; 2,033 acres or 32%, pasture land with a maximum grade of 25%; 2,050 acres or 32%, row crop land with a maximum grade of 8%; and 3 acres, other land use.

In June, the Vanderburgh County commissioners approved an ordinance prohibiting strip coal mining in the county. There has been no strip mining in the county to date, although strip mining in adjacent Warrick County has progressed to within 2

miles of the Vanderburgh County line. The ordinance sets a maximum penalty of a \$1,000 fine and/or 6 months imprisonment for each day a violation occurs.

The Indiana Geological Survey published Occasional Paper 19, "Silurian Reefs in Southwestern Indiana and Their Relation to Petroleum Accumulation," and Occasional Paper 20, "Pyrite in the Coxville Sandstone Member, Linton Formation, and Its Effect on Acid Mine Conditions Near Latta, Greene County, Indiana." Among other publications released by the Survey were two directories and three maps: "Directory of Clay and Shale Producers and Ceramic Plants in Indiana," "Directory of Dimension Stone Quarries in Indiana," "Map Showing Oil, Gas, and Gas Storage Fields in Indiana," "Map of Southwestern Indiana Showing Locations of Active Coal Mines," and "Map of Indiana Showing Thickness of Silurian Rocks and Location of Reefs and Reef-Induced Structure."

Federal mine inspectors from the Mining Enforcement and Safety Administration (MESA) conducted 376 inspections and investigations at Indiana coal mines as follows: 98 regular health and safety inspections, 86 spot inspections, 84 electrical inspections, 26 accident prevention inspections, and 82 other inspections and investigations, including such matters as accidents, technical inspections and investigations, and complaints. Federal metal and nonmetallic mine inspectors performed 393 regular inspections and 502 spot inspections at clay, cement, gypsum, peat, sand and gravel, and stone operations.

State mine inspectors from the Indiana Bureau of Mines and Mining conducted 79 health and safety inspections and 62 spot inspections at active and abandoned coal mines and coal loading docks. The State bureau also inspected the two underground gypsum mines in Martin County.

Employment and Injuries.—According to MESA, employment in Indiana's mineral industries, excluding petroleum and natural gas, totaled 8,441 persons during 1976. Coal industry employment ranked first with 47% of the total, followed by limestone and dolomite with 20%; sand and gravel, 15%; cement, 11%; gypsum, 4%; clays, 2%; and all remaining industries combined, 1%.

Injuries at coal mining operations included 1 fatality (compared with 3 fatalities in 1975), 118 nonfatal disabling

injuries, and 179 nondisabling injuries. Nonmetallic mineral producers reported 2 fatalities, 80 nonfatal disabling injuries, and 43 nondisabling injuries.

Safety trophy reawards from the Portland Cement Association were presented to the Louisville Cement Co. Logansport plant, Lone Star Industries, Inc., Greencastle plant, and the Universal Atlas Cement Div. of United States Steel Corp. Buffington plant. The plants operated in 1976 without lost-time accidents. The Louisville Cement Co. Logansport plant continued to be the leader in the Portland Cement Association, with 11 consecutive years without a chargeable lost-time accident.

The Rieth-Riley Construction Co., Inc., plant at Elkhart was the winner of the National Sand and Gravel Association's 1976 safety contest Class E competition for plants producing from 60,000 to 169,000 tons. Certificates of Achievement in Safety were awarded to contestants who operated in 1976 without lost-time accidents as follows: Class B (550,000 to 1,499,999 tons), Martin Marietta Aggregates, Indianapolis plant; Class C (225,000 to 549,000 tons), Central Aggregates, Inc., Indianapolis plant; Martin Marietta Aggregates, Clinton plant; American Aggregates Corp., Richmond plant; United States Aggregates, Inc., Hendricks County plant; and five Western Materials Co. plants—Lafayette, South Bend, Hanna, Montezuma, and Leesburg; Class D (170,000 to 224,999 tons), United States Aggregates, Inc., Indianapolis plant; Class E (60,000 to 169,000 tons), American Aggregates Corp., Carmel plant; Martin Marietta Aggregates, South Terre Haute plant; and two Western Materials Co. plants—Anderson and portable plant No. 10; and Class F (less than 60,000 tons), Western Materials Co., Starke County plant. A special certificate was awarded to Martin Marietta Aggregates for a 6-year accident-free record at its South Terre Haute plant and to Western Materials Co. for a 7-year accident-free record at its Lafayette plant.

Three Indiana operations received safety awards for an injury-free year during 1976 in the National Crushed Stone Association 51st Annual Safety Contest as follows: Group IV (less than 30,000 man-hours worked), Kickapoo Stone and Gravel Div., McMahan-O'Connor Construction Co., Peru quarry; and two Western Materials Co. quarries—Francesville and Monon.

Special safety certificates were awarded by the National Limestone Institute Inc. to Kixmiller Bros., Inc., Freelandville quarry, for 7 consecutive years without a disabling injury; Mill Creek Stone and Gravel Corp., Rich Valley quarry, and

Western Materials Co., Francesville quarry, for 5 consecutive years without a disabling injury; and Mulzer Crushed Stone Co., Cape Sandy quarry, for 4 years without a disabling injury.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Coal production in Indiana totaled 25,369,000 tons valued at \$312,990,000, an increase of 1% in quantity and 12% in value from that of 1975. The average value per ton of coal rose \$1.19 to \$12.34.

More than 98% of the coal was produced at 62 strip mines in 15 counties. The remainder was produced in two underground mines. The combined output of the two underground mines was 437,000 tons compared with 188,000 tons in 1975.

Leading producers were Peabody Coal Co., Amax Coal Company and Old Ben

Coal Co. The leading coal-producing counties were Warrick, Pike, Vermillion, and Sullivan.

Coal consumption in Indiana was 45,837,000 tons of which about 45% came from mines in the State; 20% from West Virginia, Virginia, and eastern Kentucky; 13% from Illinois; 10% from western Kentucky; 6% from Wyoming; 4% from Pennsylvania; and the remainder, 2%, from various Southeastern and Western States. Electric utilities used 64% of the coal consumed in Indiana, including most of the low-sulfur western coal; coke and gas plants used 27%; and most of the remainder was used by industrial plants.

Table 4.—Indiana: Bituminous coal production in 1976, by type of mine and county
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Production (thousand short tons)			Value (thousands)
	Under-ground	Sur-face	Under-ground	Sur-face	Total	
Clay -----	--	8	--	1,328	1,328	W
Daviess -----	--	3	--	266	266	W
Dubois -----	--	2	--	W	W	W
Fountain -----	--	1	--	W	W	W
Gibson -----	--	1	--	W	W	W
Greene -----	--	2	--	953	953	W
Knox -----	--	2	--	670	670	W
Owen -----	--	2	--	13	13	W
Perry -----	--	1	--	28	28	W
Pike -----	1	11	W	5,786	¹ 5,786	W
Spencer -----	--	9	--	571	571	W
Sullivan -----	--	5	--	2,502	2,502	W
Vermillion -----	--	2	--	2,678	2,678	W
Vigo -----	--	2	--	26	26	W
Warrick -----	1	11	W	9,387	¹ 9,387	W
Undistributed -----	--	--	437	723	1,160	\$312,990
Total -----	2	62	437	24,931	²25,369	312,990

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

¹ Incomplete total.

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

Although Indiana consumes considerably more coal than it produces, about 17% of the State's output was shipped to customers in the following States: Kentucky, Georgia, Wisconsin, Tennessee, Illinois, Missouri, Michigan, Minnesota, and Ohio.

Amax Coal announced plans to expand two of its Indiana surface coal mines. In April, the firm said it would double coal production at its Chinook mine in Clay County to 2.4 million tons annually during 1977. Expansion of the Ayrshire mine in Warrick County from 2.5 million tons to 4.5 million was announced in August. The Ayrshire mine expansion project included construction of a new 176-cubic-yard dragline, the second largest in the world. The \$27 million earth-mover was expected to be operational in the spring of 1978. Late in the year, the company created a Claims Adjustment Group at its Evansville office. The purpose of the new group is to deal with public concerns and complaints about the firm's mining activities in Indiana, Illinois, and Kentucky.

Late in the year, Lemmons & Co., a medium-size coal producer, filed for reorganization under Federal bankruptcy laws. Shortly thereafter, its surface mines were shutdown. The firm got into financial difficulties when it lost an \$868,000 law suit to the United Mine Workers Union for failure to make payments to the union's health and retirement fund.

During 1976, Evansville continued to grow in importance as a center of coal industry activity in southern Indiana, southern Illinois, and western Kentucky. In August, Consolidation Coal Co. officially opened a new regional office in Evansville with more than 100 employees to manage its mining activities in Ohio and Illinois, as well as various coal properties including those in Indiana. In September, Amax Coal announced plans to move its central division office to Evansville. A Peabody Coal Co. regional office was established earlier. Firms which supply services, equipment, and supplies to the coal industry have also located in Evansville. One of these, Frontier-Kemper Constructors, an underground coal mine construction firm, began construction of an office and repair shop complex during 1976. Indiana State University at Evansville initiated a 2-year associate degree program in mining engineering technology during 1975. Before the first students

enrolled in the program could complete their 2 years of studies, the program was expanded into a 4-year program leading to a bachelor's degree in mining engineering technology.

Coke.—Coke production from Indiana's six coke plants totaled 8,259,000 tons, 11% less than that of 1975. The value of output totaled \$680,723,000 or \$82.42 per ton.

The coke plants used 12,267,000 tons of coal valued at \$498,502,000. In addition to coke, the plants produced 1,082,000 tons of coke breeze for utilization at agglomeration plants and for other industrial uses. Most of the coke was used for metallurgical purposes by iron and steel producers and foundry operators.

Youngstown Sheet and Tube Co. cited reduced sales of steel products and falling profit margins as reasons for delaying completion of its new \$170 million, 85-oven coke plant for at least 1 year at the Indiana Harbor Works. The project was rescheduled for completion during 1978.

United States Steel Corp. started up the second of two new coke oven batteries, No. 3, at its Gary Works during 1976. The first, battery No. 2, was placed into operation during 1975. Each battery is designed to produce 900,000 tons of coke a year. New coke plant air pollution abatement facilities were also placed into operation during the year.

Peat.—Peat sales totaled 144,330 tons valued at \$1,716,000, compared with the 1975 output of 76,000 tons valued at \$1,918,000. About two-thirds of the peat was packaged and the remainder was sold in bulk form. Fourteen companies reported peat production in 10 counties—Allen, Fulton, Grant, Hamilton, Hancock, Jasper, La Porte, Marshall, St. Joseph, and Wells. The types of peat produced included moss, reed-sedge, and humus, most of which was shredded. The peat was used principally for soil conditioning and horticultural use. None was sold for use as fuel.

Petroleum and Natural Gas.—Production of crude petroleum from 4,798 wells² was 4,630,000 barrels, only 2,500 barrels less than that of 1975. Total value of crude production was \$50,421,000, an increase of 3% above that of 1975. The average value was \$10.89 per barrel, a 35 cent per barrel increase over that of 1975.

² World Oil. Feb. 15, 1977, p. 104.

Table 5.—Indiana: Crude petroleum production in 1976, by major field

Field	Year discovered	Area (acres)	Location (county)	Number of wells		Production (barrels)
				Pro- ducing	Com- pleted	
Black River Consolidated	1950	700	Posey	NA	--	109,861
Coe South	1961	460	Pike	NA	1	118,941
Elnora Central	1972	850	Daviess	NA	1	122,438
Griffin Consolidated	1938	7,540	Gibson and Posey	NA	--	482,942
			Posey and			
			Vanderburgh	NA	1	155,624
Heusler Consolidated	1938	2,290	Gibson and Knox	NA	3	119,975
Mt. Carmel Consolidated	1941	2,420	Posey	NA	--	176,439
Mt. Vernon Consolidated	1941	2,490	Gibson	NA	8	100,102
Owensville Consolidated	1940	2,210				
Owensville North			do	NA	46	195,622
Consolidated	1943	3,180	Greene	NA	5	281,448
Plummer	1969	1,200	Posey	NA	1	232,714
Springfield Consolidated	1943	2,780	Gibson, Knox,			
Union-Bowman			Pike	NA	19	192,979
Consolidated (new)	1941	16,140	Posey	NA	4	207,823
Welborn Consolidated	1941	1,900	Gibson	NA	3	105,953
Wheatonville				NA	112	2,026,876
Consolidated (new)	1949	2,160		NA		
Undistributed	XX	XX		NA		
Total	XX	XX		NA	¹ 204	4,629,737

NA Not available. XX Not applicable.

¹ Includes workovers without newly drilled footage.

Source: Petroleum Section, Indiana Geological Survey.

Table 6.—Indiana: Oil and gas well drilling completions in 1976,¹ by county

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Adams	1	--	--	--	--	--	1	1,041
Clay	3	--	1	--	--	3	7	12,506
Crawford	--	--	--	--	--	4	4	5,803
Daviess	10	--	10	1	--	28	49	52,147
Decatur	--	5	--	--	--	--	5	4,548
Dubois	--	--	3	--	1	8	12	13,483
Gibson	75	1	34	9	--	15	134	272,089
Grant	--	--	1	--	--	--	1	1,060
Greene	8	--	--	--	--	11	19	26,050
Hancock	--	1	--	--	--	--	1	995
Huntington	3	--	1	--	--	--	4	3,934
Jackson	--	--	--	--	--	1	1	540
Jasper	--	--	1	--	--	--	1	--
Jay	--	--	1	--	--	--	1	1,031
Jennings	--	1	--	--	--	--	1	886
Knox	2	2	3	1	--	9	17	26,358
Lake	--	--	--	--	--	1	1	350
Lawrence	--	--	--	--	--	1	1	1,170
Madison	--	1	2	--	--	--	3	2,706
Martin	--	--	--	--	1	2	3	2,653
Miami	2	--	--	--	--	--	2	--
Owen	--	--	--	--	--	2	2	2,987
Perry	2	--	--	--	--	7	11	7,949
Pike	13	--	3	1	1	7	25	26,902
Posey	40	--	24	1	--	32	103	213,278
Rush	--	3	--	--	--	--	3	2,640
Shelby	--	1	--	--	--	--	1	927
Spencer	13	--	13	2	4	15	47	38,096
Steuben	1	--	1	--	1	1	2	6,695
Sullivan	1	--	1	1	--	6	9	13,860
Vanderburgh	16	--	15	3	--	4	38	71,064
Vigo	--	--	--	--	--	4	4	6,356
Warrick	1	--	1	--	--	1	1	1,925
Wells	--	--	--	--	--	1	3	3,886
Total	² 3 190	³ 15	³ 4 116	25	8	³ 163	517	825,915

¹ Does not include service wells (water input, saltwater disposal, water supply, or gas input wells). Also does not include wells drilled in connection with gas storage operations.² Includes oil wells completed in secondary recovery projects.³ Includes workovers without newly drilled footage.⁴ Includes dry holes completed in secondary recovery projects.

Source: Petroleum Section, Indiana Geological Survey.

Natural gas production decreased 45% in quantity and 26% in value. The 192 million cubic feet produced from 541 wells³ accounted for only 0.05% of the 425,221 million cubic feet of gas used by Indiana consumers during 1976. Natural gas consumption in the State was divided as follows: Industrial, 46%; residential, 36%; commercial, 15%; electrical utilities, 1%; and natural gas pipeline companies and other consumers, 2%. Because of shortages and curtailments, natural gas consumption in 1976 was 11% less than in 1975 and 20% less than in 1974.

Reserves at the end of 1976 amounted to 22,256,000 barrels of crude petroleum and 45,401 million cubic feet of natural gas, according to the American Petroleum Institute and the American Gas Association. Compared with yearend 1975, proved reserves of crude petroleum increased 227,000 barrels, and reserves of natural gas decreased 14,438 million cubic feet. Of the natural gas reserves at yearend 1976, 44,409 million cubic feet was held in underground storage reservoirs.

According to the Indiana Geological Survey, the number of wells drilled for oil and gas during 1976 totaled 517, an increase of 30% over the 399 wells drilled in 1975. Total footage drilled increased 25%, from 659,869 feet in 1975 to 825,915 feet in 1976. Of the 517 wells drilled, 196 were exploratory and 321 were for primary development. The success ratio of exploratory drilling was 16.8% with 25 oil well and 8 gas well discoveries. The discovery wells resulted in 3 new-field discoveries (1 oil and 2 gas), 17 new pool discoveries (15 oil and 2 gas), and 13 extensions to existing pools (9 oil and 4 gas). Of these discoveries, 28 were in Mississippian rocks, 3 in Pennsylvanian rocks, 1 in Devonian rocks, and 1 in Ordovician rocks.

Success in expansion of a productive reservoir in Mississippian rocks in the Owensville North Consolidated field in Gibson County, coupled with discovery of new oil reservoirs in Mississippian rocks in the Union-Bowman Consolidated field in Gibson County, added greatly to the expanded drilling activity during 1976. Most of the discoveries were in the Salem Limestone of Mississippian age which signaled a new trend in exploration away from shallow structural or reef-controlled accumulations

of oil to a search for stratigraphically entrapped accumulations in deeper carbonate rocks.

A total of 34 of Indiana's 92 counties reported oil and gas drilling activity during 1976, and 24 of the 34 counties reported finding oil or gas. Gibson County with 134 wells and adjoining Posey County with 103 wells were the two most active counties for the second consecutive year, accounting for 46% of the wells and 59% of the footage drilled in 1976.

Six petroleum refineries were in operation at the beginning of the year with a combined crude oil distillation capacity of 559,300 barrels per calendar day. During the year, American Oil Co. increased its Whiting refinery capacity by 5,000 barrels per day, Indiana Farm Bureau Cooperative Association, Inc., increased its Mt. Vernon refinery capacity by 1,200 barrels per day, and Rock Island Refining Corp. increased its Indianapolis refinery capacity by 10,600 barrels per day. Late in May, the Atlantic Richfield Co. refinery in East Chicago was purchased by Energy Cooperative Inc., a group of nine agricultural cooperatives. At yearend, the six operating refineries had a combined crude oil distillation capacity of 576,100 barrels per calendar day. These six operating refineries and their capacities at yearend are as follows in barrels per calendar day: American Oil Co., 365,000 and Energy Cooperative Inc., 126,000, both in Lake County; Rock Island Refining Corp., 43,200 in Marion County; Indiana Farm Bureau Cooperative Association, Inc., 21,200 in Posey County; Laketon Asphalt Refining Co., 8,500 in Wabash County; and Gladieux Refining, Inc., 12,200 in Allen County.

In July, the Indiana Farm Bureau Cooperative refinery at Mt. Vernon began receiving foreign crude oil for the first time. By yearend, the refinery processed 1.5 million barrels of foreign crude oil.

Crude oil input to Indiana's refineries totaled 176,750,000 barrels in 1976, compared with 163,277,000 barrels in 1975. Crude oil shipped to Indiana from foreign sources increased slightly from 19% of the total input in 1975 to 20% in 1976. About 29% of Indiana's 4.6-million-barrel crude oil production was sent to refineries within the State, the remainder went to refineries in States south and east of Indiana.

³ World Oil. Feb. 15, 1977, p. 106.

NONMETALS

Abrasives.—Hindustan Whetstone Co. fabricated whetstones from sandstone quarried near Orleans in Orange County. Output of whetstones increased significantly in both quantity and value compared with that of 1975. Metallic abrasives were manufactured by The Wheelabrator Corp. at Mishawaka in St. Joseph County. The quantity of metallic abrasives sold or used was nearly the same as in 1975.

Cement.—Indiana's five cement plants sold or used 2,490,000 tons of portland cement valued at \$73,432,000 and 396,000 tons of masonry cement valued at \$14,270,000. Compared with 1975, portland cement increased 14% in quantity and 16% in value; masonry cement increased 15% in quantity and 16% in value. The average mill value of portland cement increased 62 cents per ton to \$29.49 and masonry cement increased 29 cents per ton to \$36.04.

About 94% of the portland cement sold or used was Type I (general construction use) and Type II (moderately low heat and moderate degree of resistance to sulfate attack). The remainder, 6%, was comprised mostly of Type III (high-early-strength).

Disposition of portland cement shipped by Indiana manufacturers was as follows: 58% to ready-mix concrete producers; 20% to concrete product manufacturers for concrete blocks, concrete pipes, precast prestressed concrete, and other concrete products; 11% to highway contractors; 8% to building material dealers; and the remainder to other contractors and for miscellaneous uses.

The amount of cement consumed in Indiana is only about two-thirds of the quantity produced. The remainder is exported to other States. Apparent consumption of portland cement in Indiana during 1976 was 1,700,000 tons, an increase of 10% over that of 1975. Apparent consumption of masonry cement increased about 18% to 116,000 tons.

In June, Lehigh Portland Cement Co. brought its new cement kiln online at its Virgil I, Grissom plant at Mitchell, in Lawrence County. The 360-foot preheater rotary kiln along with an additional clinker grinding mill increased the plant's annual capacity 50% to 750,000 tons. The kiln's fuel consumption per unit of output is about 30% less than that of the two older kilns at the plant. The increased capacity cost \$13.4 million, 25% of which was for pollution control devices to bring the plant into compliance with Federal and State regulations.

Clays.—Production of clay and shale totaled 1.3 million tons valued at \$2.3 million, an increase of 16% in quantity and 18% in value. Common clay and shale accounted for more than 99% of the total output, and less than 1% was fire clay. Clay and shale was produced by 23 companies with 27 mines in 17 counties. Seven companies with 11 mines produced 76% of the State's clay and shale: Louisville Cement Co. in Cass and Clark Counties; Hydraulic-Press Brick Co. in Morgan County; Lone Star Industries, Inc., in Putnam County; Log Cabin Coal Co. in Clay County; C & F Shale Co. in Clay County; American Brick Co. in Lake County; and General Shale Products Corp. in Morgan County.

Leading clay and shale producing counties were Clay County with 330,000 tons valued at \$481,000 and Morgan County with 296,000 tons valued at \$424,000. Together, Clay and Morgan Counties accounted for 49% of the total tonnage and 39% of the total value.

About 41% of all production was used in cement manufacturing; 37% in brick manufacturing; 4% in structural tile; 3% in sewer pipe; 1% in drain tile; and the remainder, 14%, in lightweight aggregate, flower pots and other pottery, ceramic tile, fire brick, and various other clay and shale products.

Several firms had to lay off employees and shut down part or all of their operations

Table 7.—Indiana: Clays sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Total ¹	
	Quantity	Value	Quantity	Value	Quantity	Value
1972 -----	W	W	1,419	2,462	² 1,419	² 2,465
1973 -----	³ 43	³ 174	1,893	2,394	1,436	2,568
1974 -----	26	118	1,066	1,828	1,092	1,947
1975 -----	2	16	1,092	1,945	1,094	1,961
1976 -----	2	21	1,268	2,288	1,265	2,308

W Withheld to avoid disclosing company proprietary data; excluded from total.

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

² Includes a small amount of ball clay.

³ Includes a small amount of kaolin.

when natural gas supplies were curtailed late in the year. The firm had interruptible supply contracts with their natural gas distributors. Some firms continued operations by substituting petroleum fuels for natural gas, and others planned to experiment with coal. The shortages of natural gas were brought about by increased demand for gas by residential and commercial users and declining natural gas reserves.

Arketex Ceramic Corp. closed one of its two tile plants at Brazil in Clay County and sold the other to Oxide & Chemical Corp. Thomas Moulding Brick shut down its brick plant near Martinsville in Morgan County.

Gypsum.—Crude gypsum production from Indiana's two gypsum mines increased 10% over that produced in 1975. National Gypsum Co. and United States Gypsum Co. each operated underground mines near Shoals and calcined gypsum at plants adjacent to the mines. U.S. Gypsum also calcined gypsum imported from Michigan by lake carrier at a plant near East Chicago, Lake County. Calcined gypsum production increased 14% over the previous year. Calcined gypsum was used mainly in the manufacture of wallboard and sheathing for the building construction industry.

Universal Gypsum Co. of Indiana, Inc., at Elkhart, Elkhart County, processed and marketed byproduct gypsum produced chemically by Miles Laboratories, Inc. The operation was taken over completely by Miles during midyear. Output of byproduct gypsum in 1976 was less than that of 1975; however, the value of output increased. Byproduct gypsum was used mainly in food processing and products requiring gypsum of high-purity.

Lime.—Lime production in Indiana in-

creased about 13% in quantity and 17% in value. Marblehead Lime Co. produced quicklime in the Nation's second largest plant at Buffington, Lake County, and Inland Steel Co. produced quicklime at its Indiana Harbor Works, also in Lake County. At both plants, the lime is produced from limestone transported from quarries in Michigan by lake freighters. Indiana's lime consumption during 1976 totaled 1,987,000 tons, 10% more than that of 1975. Most of the lime was used by the steel industry in steelmaking furnaces.

Oxygen, Nitrogen, and Argon.—In September, the world's largest air separation unit went into operation at the Burns Harbor plant of Union Carbide Corp., Linde Div. The unit is capable of producing 2,000 tons per day of high-purity gaseous oxygen for use in steelmaking furnaces. In addition to oxygen, the plant will produce high-purity gaseous nitrogen and more than 1 million cubic feet per day of refined argon. A second unit of equal size is under construction at the site with a completion date in the middle of 1977. The Burns Harbor units will make 10 major air separation units in northwest Indiana producing 1,200 tons or more of oxygen in the world's largest atmospheric gas complex.

Perlite (Expanded).—Production of expanded perlite was 15,171 tons, 2% less than that produced in 1975. The quantity sold or used totaled 15,102 tons valued at \$1,228,000, a decrease of less than 1% in quantity but an increase of 9% in value over that of 1975. Average value per ton increased \$7.20 to \$81.28. Crude perlite shipped to Indiana from mines in New Mexico was expanded at five plants: United States Gypsum Co. at its gypsum plants in

Lake and Martin Counties; National Gypsum Co. at its gypsum plant in Martin County; Grefco, Inc., near Crawfordsville, Montgomery County; and Chemrock Corp. near Lafayette, Tippecanoe County. The principal uses for perlite in Indiana were for plaster aggregate, filter aid, and insulation.

Sand and Gravel.—Sand and gravel production totaled 25.9 million tons valued at \$45.5 million, an increase of 20% in quantity and 29% in value over that of 1975. The average unit value increased 13 cents per ton to \$1.76.

Construction sand and gravel accounted for 99% of the total output and 97% of the total value. Of the 25.5 million tons of construction sand and gravel produced, 53% or 13.5 million tons was sand valued at \$19.5 million, and 47% or 12 million tons was gravel valued at \$24.8 million. The average unit value of construction sand was \$1.44 per ton and construction gravel averaged \$2.07 per ton.

Industrial sand and gravel totaled 366,000 tons and accounted for 1% of the total output and 3% of the total value. Most of it (364,000 tons) was industrial sand valued at \$3.21 per ton. The small amount of industrial gravel produced (2,000 tons) averaged \$2 per ton in value.

Among the States, Indiana ranked 10th in

the output of sand and gravel, accounting for 3% of total U.S. production.

Sand and gravel was mined at 204 locations in 68 counties. Marion County was the leading producer with 2.4 million tons, followed by Hamilton County with 1.5 million tons, and Tippecanoe County with 1.3 million tons. Only 4 mines produced 700,000 tons or more each; 7, between 400,000 and 700,000 tons each; 26, between 200,000 and 400,000 tons each; 51 between 100,000 and 200,000 tons each; 31, between 50,000 and 100,000 tons each; and 85, less than 50,000 tons each, of which 55 produced less than 25,000 tons each. American Aggregates Corp., Western Materials Co., and Martin Marietta Corp., were the leading producers.

The principal uses for construction sand and gravel were as follows: 41%, for concrete aggregate; 21%, for asphaltic concrete and other bituminous mixtures; 14%, for roadbase and coverings; 13%, for fill; 9%, for concrete products; and 2%, for other uses.

About 91% of Indiana's sand and gravel output was transported by truck. The remainder was transported by rail, water, and other means.

Irving Materials, Inc., merged with Connersville Gravel Co. which was renamed the Connersville Div. of Irving Materials, Inc.

Table 8.—Indiana: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	8,869	15,748	10,401	19,436
Concrete products (cement blocks, bricks, pipe, etc.)	1,717	2,890	2,401	4,256
Asphaltic concrete aggregates and other bituminous mixtures	4,101	7,181	5,376	10,143
Roadbase and coverings	3,250	4,607	3,574	5,788
Fill	2,973	3,233	3,190	3,918
Other uses	399	619	576	808
Total ¹	21,810	34,281	25,518	44,348

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

Table 9.—Indiana: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Allen	8	755	1,107	8	674	1,068
Bartholomew	2	253	378	2	W	W
Blackford	—	—	—	1	4	4
Boone	3	188	308	3	188	330
Cass	2	W	434	3	323	578
Clark	1	115	207	2	124	224
Dearborn	2	W	W	2	W	510
De Kalb	6	321	456	6	414	600
Delaware	3	315	425	2	W	W
Elkhart	8	491	804	9	548	806
Fayette	1	231	410	1	W	W
Fountain	2	W	W	3	742	1,433
Fulton	4	338	562	1	W	W
Grant	2	W	W	3	366	679
Hamilton	4	1,584	3,255	4	1,522	3,163
Hancock	4	208	374	3	167	372
Henry	3	160	302	4	527	1,028
Jay	1	W	122	1	W	W
Johnson	3	193	288	3	223	382
Kosciusko	6	482	457	6	796	1,012
Lagrange	8	140	148	6	155	213
La Porte	4	818	1,501	3	497	1,228
Madison	7	528	699	7	503	801
Marion	5	1,811	2,569	6	2,391	4,373
Marshall	2	W	W	2	292	544
Miami	4	315	581	3	656	1,475
Montgomery	3	48	17	3	48	19
Morgan	6	458	824	8	943	1,531
Noble	6	219	323	7	236	365
Parke	1	45	86	2	W	W
Pike	1	5	15	1	5	15
Putnam	3	74	98	3	71	110
Rush	2	12	14	2	18	23
St. Joseph	8	1,066	1,781	8	1,018	1,457
Shelby	3	342	608	4	486	585
Steuben	4	243	325	5	414	482
Sullivan	3	329	488	3	204	377
Switzerland	1	1,279	W	1	W	W
Tippecanoe	5	1,238	1,973	4	1,268	2,133
Vermillion	2	W	W	4	501	904
Vigo	3	W	W	6	389	661
Warren	4	677	1,285	5	1,044	2,479
Wayne	4	607	1,079	4	513	1,026
Other counties ¹	32	5,750	10,929	40	7,611	12,282
Total ²	186	21,641	35,234	204	25,384	45,521

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

¹ Includes Adams, Carroll, Clinton (1976), Daviess, Floyd, Franklin, Gibson (1976), Greene, Harrison, Howard, Huntington, Jackson, Jasper, Knox, Lake, Ohio (1976), Owen, Porter, Posey, Randolph, Spencer (1976), Tipton, Vanderburgh (1976), Wabash, and Whitley Counties.

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

Stone.—Indiana's stone industry was comprised of 75 companies operating 123 quarries in 50 counties. Stone production totaled 28.5 million tons valued at \$72.2 million, a decrease of 2% in quantity but an increase of 5% in value. Stone output in 1976 was as follows: Crushed and broken limestone and dolomite, 28.2 million tons with a value of \$59.4 million; dimension limestone, dolomite, and sandstone, 263,000 tons with a value of \$12.8 million; and marl, 24,000 tons with a value of \$40,000. The average value of crushed and broken

limestone and dolomite increased 9 cents per ton to \$2.11. Marl increased 23 cents to an average value of \$1.67 per ton.

Three quarries had an output exceeding 900,000 tons each; 12, between 500,000 and 900,000 tons each; 60, between 100,000 and 500,000 tons; and 48, less than 100,000 tons each, of which 33 produced less than 25,000 tons each. Crawford County, with 2.9 million tons of crushed and broken stone, was the leading producer, followed by Clark and Putnam Counties with 2.8 million tons each.

Crushed and broken stone was produced by 62 companies at 106 quarries. Ralph Rogers & Co., Inc., Mulzer Crushed Stone Co., France Stone Co., and Irving Bros. Gravel Co., Inc., were Indiana's largest producers. Seven companies mined marl from 10 pits in Elkhart, Lagrange, Noble, and Steuben Counties.

Among the States, Indiana ranked first in the output of dimension stone, most of which was dimension limestone produced in Monroe and Lawrence Counties. Leading producers of dimension limestone were Victor Oolitic Stone Co. and Indiana Limestone Co. Dimension sandstone was produced in Lawrence County. Sixteen companies produced dimension stone at 21 quarries. Indiana's output of dimension stone in 1976 increased 4% in quantity and 16% in value over that in 1975.

Principal uses for Indiana's stone output were as follows: 59% of total stone tonnage for roadbase and paving materials; 13% for concrete aggregate; 12% for agricultural limestone; 11% for cement manufacture; and the remainder, 5%, for railroad ballast, riprap and jettystone, rough and dressed architectural dimension stone, and miscellaneous chemical and industrial uses. About 93% of the stone was transported by truck, 5% by water, and 2% by railroad.

A 3-week strike in the dimension limestone industry ended in late July with several employee unions accepting a new labor contract. The contract provides \$1.27½ an hour increase in wages over a 3-year period. Seven and one-half cents of the total goes to a trust fund to promote the use and sale of dimension limestone in the building industry. The employee contribution to the fund is matched by management for a total of 15 cents. The fund had been financed by a previous union-

management contribution totaling 10 cents an hour.

The 40-ton limestone statue of Washington crossing the Delaware was completed in January. During May and June, the statue was displayed in Indiana and at various cities along the highway route to Washington Crossing Park, where it was permanently installed and dedicated on July 5. An inscription carved into the limestone base of the statue states: "This symbolic statue is donated to the people of the United States of America in celebration of the American Revolution Bicentennial. It is a gift from the citizens of the Bedford limestone area in the custody of the Washington Crossing Foundation. Both groups have demonstrated outstanding effectiveness in the promotion of patriotism in America."

Midwest Quarries Co., Inc., a dimension stone producer, and Northern Indiana Stone Co., a crushed stone producer, ceased operation during 1976. Berry Materials Corp. purchased the assets of Ludwig Stone Co.

Radcliff, Inc., was acquired by Western Materials Div. of Medusa Corp. The acquisition included a deposit of high-calcium limestone in Orange County estimated to include more than 100 million tons of stone. The firm signed a contract to supply 2.3 million tons of the stone to a utility for use in a sulfur dioxide removal system.

Stone exploration activities indicated an increasing interest in Indiana's high-calcium limestone resources. The principal interest in these limestone resources were for such industrial applications as flux in glass and steelmaking, and stone for stack-gas desulfurization processes.

Table 10.—Indiana: Stone sold or used by producers, by use
(Thousand short tons and thousand dollars unless otherwise specified)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension: ¹				
Rough architectural ----- thousand cubic feet...	1,701	3,350	1,668	3,367
Irregular shaped stone ----- do....	121	232	185	256
Rubble ----- do....	189	130	W	W
Flagging ----- do....	W	W	113	106
Cut stone ----- do....	251	3,074	404	5,010
Sawed stone ----- do....	654	3,079	606	2,864
House stone veneer ----- do....	425	1,027	425	1,019
Other uses ² ----- do....	103	112	243	165
Total ³ ----- thousand short tons...	254	11,004	263	12,787
Crushed and broken: ⁴				
Bituminous aggregate -----	3,096	6,715	2,637	5,960
Concrete aggregate -----	3,220	6,597	3,789	8,340
Dense-graded roadbase stone -----	7,116	14,552	4,957	10,820
Macadam aggregate -----	2,348	4,841	2,145	4,668
Surface treatment aggregate -----	849	1,850	1,877	4,106
Unspecified concrete aggregate and roadstone -----	5,595	10,954	5,004	10,300
Agricultural limestone -----	2,498	5,202	3,324	7,231
Cement manufacture -----	2,801	3,868	3,161	4,012
Railroad ballast -----	271	513	379	732
Riprap and jetty stone -----	250	598	294	842
Other uses ⁵ -----	649	2,155	619	2,409
Total ³ -----	28,693	57,345	28,137	59,418
Grand total ³ -----	28,947	68,850	28,450	72,205

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

¹ Includes limestone, dolomite, and sandstone.

² Includes stone used for dressed construction stone, dressed flagging, rubble (1976), and rough flagging (1975).

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

⁴ Includes limestone, dolomite, and marl.

⁵ Includes stone used for glass, mineral food, sulfur dioxide removal (1976), filter stone, fill (1976), mine dusting, asphalt filler, soil conditioning, and flux stone.

Table 11.—Indiana: Crushed and broken limestone and dolomite sold or used
by producers, by county
(Thousand short tons and thousand dollars)

County	1975		1976	
	Quantity	Value	Quantity	Value
Allen -----	2,160	4,602	1,818	3,767
Cass -----	1,049	1,761	1,026	1,668
Clark -----	2,391	4,197	2,770	4,977
Crawford -----	3,091	5,632	2,914	5,674
Hamilton -----	1,217	2,651	1,273	2,970
Harrison -----	680	1,302	542	1,170
Johnson -----	1	3	---	---
La Porte -----	1	2	---	---
Lawrence -----	1,736	3,399	1,991	3,778
Monroe -----	751	1,308	W	W
Orange -----	561	1,174	631	1,382
Posey -----	2	8	---	---
Pulaski -----	W	W	390	850
Putnam -----	2,755	5,386	2,752	5,808
Sullivan -----	20	84	21	102
Switzerland -----	72	166	W	136
Washington -----	W	W	215	W
Wayne -----	240	549	222	613
White -----	W	W	309	727
Undistributed ¹ -----	11,937	25,580	11,289	25,756
Total ² -----	28,665	57,306	28,163	59,378

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

¹ Includes Adams, Bartholomew, Blackford, Carroll, Decatur, Delaware, Grant, Howard, Huntington, Jasper, Jay, Jennings, Lake (1975) Madison, Marion, Miami, Morgan, Newton, Owen, Perry, Randolph, Ripley, Rush, Scott, Shelby, Vigo, Wabash, and Wells Counties.

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

Table 12.—Indiana: Calcareous marl production

Year	Number of producers	Short tons	Value
1972 -----	9	26,137	\$24,171
1973 -----	10	41,241	48,981
1974 -----	10	48,602	62,215
1975 -----	9	28,373	40,845
1976 -----	7	23,972	39,973

Sulfur.—American Oil Co. and Energy Cooperative Inc. recovered sulfur from crude petroleum at their refineries in Lake County. Sales increased 3% in volume and decreased 15% in value. The Energy Cooperative Inc. refinery was formerly owned and operated by Atlantic Richfield Co.

METALS

Aluminum.—Aluminum ingots and thin gage aluminum sheet were produced by the Aluminum Co. of America (Alcoa) at its smelter and fabricating operations near Evansville in Warrick County. Alumina was barged to the smelter from Mobile, Ala., and Point Comfort, Tex. Ingot production decreased 5% in quantity and increased 6% in value. Aluminum cans and scrap recycled at the plant totaled about 47 million pounds during 1976.

The Robert C. Morris Memorial Citation was awarded to Alcoa by the Indiana Energy Office of the Indiana Department of Commerce. The citation, Indiana's highest award for energy conservation, was in recognition of Alcoa's efforts in the practice and promotion of energy conservation at the Warrick operations. The plant has about 50 employees involved in energy management and usage.

Pig Iron and Steel.—Inland Steel Co., United States Steel Corp., and Youngstown Sheet & Tube Co. each produced pig iron and steel in Lake County, and Bethlehem Steel Corp. produced pig iron and steel in Porter County.

Pig iron production was 17,439,000 tons in 1976, an increase of 1,782,000 tons or 11%. Indiana ranked second in the Nation in pig iron production after Pennsylvania. Pig iron shipments totaled 17,461,000 tons valued at \$3,273,078,000 compared with shipments in 1975 of 15,648,000 tons valued at \$2,707,967,000. The average value of pig

iron increased 8%, from \$173.06 per ton in 1975 to \$187.45 per ton in 1976. Pig iron was produced in 27 blast furnaces, of which 19 were in operation at the beginning of the year, 24 (maximum for the year) were in operation during June, and 16 were in operation at the end of the year.

Steel production reported by the American Iron and Steel Institute was 22,178,000 tons, 12% more than Indiana's 1975 output of 19,807,000 tons. Indiana ranked third in steel production after Pennsylvania and Ohio. Steel was produced in basic oxygen furnace shops by each of the four primary producers and in open-hearth furnaces by Inland Steel Co. and Youngstown Sheet & Tube Co. Steel was also produced from scrap in electric furnaces.

During 1976, U.S. Steel's Gary Works produced its 300-millionth ton of steel, celebrated its 70th anniversary, and hosted a Bicentennial open house for 107,000 visitors. Also during the year, work was completed on modernization of the 80-inch hot strip mill, conversion of the continuous slab caster reheating furnace from natural gas fuel to coke oven gas with oxygen enrichment, and construction of three electrostatic precipitators to collect dust produced by "scarfing," a process where impurities are burned from the surface of semifinished steel. Plans were announced to reactivate two foundry open hearths after being equipped with precipitators to clean furnace exhaust gases. Idle since 1974, the furnaces will make steel casting parts used in the plant.

Inland Steel placed a water-recycling system in service for six of its eight blast furnaces. The other two furnaces were similarly equipped in 1975. The system improved the removal of solids from blast furnace process water from an efficiency of 97.6% to 99.8%. The firm's expenditures for air and water pollution equipment totaled \$34.7 million in 1976 and climbed to \$122 million since the beginning of 1972. The cost of operating and maintaining pollution control equipment in 1976 increased 80% to \$20.9 million, compared with \$11.6 million in 1975.

Inland Steel Co. significantly reduced energy requirements to produce a ton of steel in 1976. Energy usage per ton of steel shipped was reduced 14% to 30.8 million Btu's, compared with 35.2 million Btu's in

1975. However, the savings were largely offset by fuel cost increases which went up 13%.

Other Metals.—Antimonial lead and lead alloying elements were recovered by USS Lead Refinery, Inc., a division of UV Industries, Inc., at its secondary lead refinery in Lake County.

ASARCO Incorporated began construction of a new facility at its Whiting plant in Lake County to refine crude nickel sulfate produced at its copper refineries. The new facility was planned for completion in 1977. Refined nickel sulfate is sold principally for nickel plating.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Hindustan Whetstone Co ---	Box 501 Bedford, Ind. 47421	Quarry and plant --	Orange.
Cement:			
Lehigh Portland Cement Co. ^{1,2}	718 Hamilton St. Allentown, Pa. 18105	Plant -----	Lawrence.
Lone Star Industries, Inc. ²	One Greenwich Plaza Greenwich, Conn. 06830	---do -----	Putnam.
Louisville Cement Co. ^{1,2} ---	501 South 2d St. Louisville, Ky. 40202	---do -----	Cass and Clark.
United States Steel Corp. ³ -	600 Grant St. Pittsburgh, Pa. 15230	---do -----	Lake.
Clays:			
American Brick Co -----	6558 West Fullerton Ave. Chicago, Ill. 60635	Pit and plant ---	Do.
C & F Shale Co -----	203 South Walnut St. Brazil, Ind. 47834	---do -----	Clay.
General Shale Products Corp.	Box 96 Mooreville, Ind. 46158	---do -----	Morgan.
Hydraulic-Press Brick Co -	705 Olive St. St. Louis, Mo. 63101	---do -----	Do.
Log Cabin Coal Co -----	304 South Depot St. Brazil, Ind. 47834	Pits -----	Clay.
Coal (bituminous):			
Amax Coal Co -----	105 South Meridian St. Indianapolis, Ind. 46225	Strip mine and plant.	Clay, Pike, Sullivan, Warrick.
Old Ben Coal Co -----	10 South Riverside Plaza Chicago, Ill. 60606	---do -----	Pike.
Peabody Coal Co -----	301 North Memorial Dr. St. Louis, Mo. 63102	Strip and under- ground mines, plant.	Greene, Sullivan, Vermillion, Warrick.
Coke:			
Citizens Gas & Coke Utility	2020 North Meridian St. Indianapolis, Ind. 46202	Plant -----	Marion.
Indiana Gas & Chemical Corp.	1341 Hulman St. Terre Haute, Ind. 47802	---do -----	Vigo.
Inland Steel Co -----	3210 Watling St. East Chicago, Ind. 46312	---do -----	Lake.
Youngstown Sheet and Tube Co.	Box 900 Youngstown, Ohio 44501	---do -----	Do.
Gypsum:			
National Gypsum Co. ⁴ ---	325 Delaware Ave. Buffalo, N.Y. 14202	Underground mine and plant.	Martin.
United States Gypsum Co. ⁴	101 South Wacker Dr. Chicago, Ill. 60606	---do -----	Do.
Lime: Marblehead Lime Co ---	300 West Washington St. Chicago, Ill. 60606	Plant -----	Lake.
Peat:			
Herb Felger Peat Moss and Black Dirt.	9912 Valentine Rd. Fort Wayne, Ind. 46808	Bog and plant ---	Allen.
Iroquois Peat Moss, Inc ---	Route 1, Box 22 Monon, Ind. 47959	---do -----	Jasper.
Millburn Peat Co., Inc ---	Box 236 La Porte, Ind. 46350	---do -----	La Porte.
Sher Products, Inc -----	Route 5 Greenfield, Ind. 46150	---do -----	Hancock.
Perlite, expanded:			
Chemrock Corp -----	End of Osage St. Nashville, Tenn. 37208	Plant -----	Tippecanoe.
Grefco, Inc -----	2111 Enco Dr. Oakbrook, Ill. 60521	---do -----	Montgomery.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Petroleum refineries:			
American Oil Co. ⁵ -----	2400 New York Ave., Box 710 Whiting, Ind. 46394	Refinery -----	Lake.
Energy Cooperative, Inc. ⁵ --	3500 Indianapolis Blvd. East Chicago, Ind. 46312	----do -----	Do.
Indiana Farm Bureau Cooperative Association, Inc.	1200 Refinery Rd. Mt. Vernon, Ind. 47620	----do -----	Posey.
Rock Island Refining Corp -	Box 68007 Indianapolis, Ind. 46268	----do -----	Marion.
Roofing granules:			
H. B. Reed & Co., Inc ----	8149 Kennedy Ave. Highland, Ind. 46322	Plants -----	Lake.
Sand and gravel:			
American Aggregates Corp. ²	Garst Ave. at Ave. B Greenville, Ohio 45331	Pits and plants ---	Hamilton, Marion, Wayne.
Martin Marietta Corp. ² ----	Box 789 Cedar Rapids, Iowa 52406	----do -----	Various.
Western Materials Co. ² ----	Box 150, 600 Morland Dr. Lafayette, Ind. 47901	----do -----	Do.
Smelters and refineries (nonferrous):			
Aluminum Company of America.	Newburgh, Ind. 47630 -----	Smelter -----	Warrick.
ASARCO Incorporated ----	2330 Indianapolis Blvd. Whiting, Ind. 46394	Plant -----	Lake.
NL Industries, Inc -----	Beech Grove, Ind. 46107 ---	----do -----	Marion.
USS Lead Refining Inc ----	5300 Kennedy Ave. East Chicago, Ind. 46312	----do -----	Lake.
Stone:			
France Stone Co. ⁶ -----	Box 1928 Toledo, Ohio 43603	Quarries -----	Allen and Putnam.
Irving Bros. Gravel Co., Inc. ⁶	3888 Garthwaite Rd. Marion, Ind. 46952	----do -----	Delaware, Grant, Huntington, Wells.
Mulzer Crushed Stone Co --	Box 248 Tell City, Ind. 47586	Quarries, mine, plants.	Crawford and Perry.
Ralph Rogers & Co., Inc. ⁶ -	Box 849 Bloomington, Ind. 47401	----do -----	Lawrence, Monroe, Newton.

¹ Also clays.² Also stone.³ Also coke.⁴ Also expanded perlite.⁵ Also recovered sulfur.⁶ Also sand and gravel.

The Mineral Industry of Iowa

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Iowa Geological Survey for collecting information on all minerals except fuels.

By Waldemar M. Dressel¹ and Fred H. Dorheim²

Iowa ranked 32d in the Nation in value of mineral production during 1976. Cement production was up 8%; clay was up 6%; and gypsum was up 23% over 1975 production levels. Coal production was down about 1%, but the value was up 21% over that of 1975. Sand and gravel and stone production was down slightly. Total value for mineral production reached an alltime high \$216 million.

Nonmetallic minerals dominated the State, with production accounting for approximately 96% of the total mineral out-

put; coal accounted for the remainder. Iowa mineral production value was distributed as follows: Portland and masonry cement, 42%; stone (excluding dimension), 35%; construction sand and gravel, 12%; gypsum, 4%; clays, 1%; and coal, lime, gemstones, industrial sand and gravel, peat, and others, the remainder. Petroleum has not been produced since 1963.

¹ State Liaison Officer, Bureau of Mines, Rolla, Mo.

² Geologist, Iowa Geological Survey, Iowa City, Iowa.

Table 1.—Mineral production in Iowa¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry -----thousand short tons--	62	\$2,933	76	\$4,143
Portland -----do-----	2,258	73,786	2,438	86,107
Clays -----do-----	959	1,916	1,017	2,245
Coal (bituminous) -----do-----	622	6,891	616	8,351
Gypsum -----do-----	1,208	6,546	1,486	8,288
Sand and gravel -----do-----	15,410	26,844	² 15,206	² 26,277
Stone -----do-----	30,336	73,732	³ 30,272	³ 75,921
Value of items that cannot be disclosed:				
Gem stones, lime, peat, sand and gravel (industrial, 1976), and stone (dimension, 1976) -----	XX	3,092	XX	4,695
Total -----	XX	195,740	XX	216,027
Total 1967 constant dollars -----	XX	77,454	XX	\$ 77,662

^p Preliminary. 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 "Value of items that cannot be disclosed."

³ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Iowa, by county ¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adair	W	W	Stone.
Adams	W	W	Do.
Allamakee	W	W	Stone, sand and gravel.
Appanoose	W	\$2,047	Stone, clays, sand and gravel.
Audubon	W	—	—
Benton	W	1,188	Stone, sand and gravel.
Black Hawk	W	W	Do.
Boone	\$1,460	569	Sand and gravel.
Bremer	W	W	Stone, sand and gravel.
Buchanan	W	W	Do.
Buena Vista	48	W	Sand and gravel.
Butler	W	309	Stone, sand and gravel.
Carroll	524	504	Sand and gravel.
Cass	W	W	Stone.
Cedar	W	W	Stone, sand and gravel.
Cerro Gordo	W	W	Cement, stone, clays, sand and gravel.
Cherokee	402	652	Sand and gravel.
Chickasaw	W	342	Stone, sand and gravel.
Clarke	W	W	Stone.
Clay	176	160	Sand and gravel.
Clayton	1,760	1,834	Sand and gravel, stone.
Clinton	W	2,204	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	W	W	Sand and gravel, clays.
Davis	W	W	Stone, sand and gravel.
Decatur	W	W	Stone.
Delaware	W	W	Stone, sand and gravel.
Des Moines	W	W	Stone, gypsum, sand and gravel.
Dickinson	219	338	Sand and gravel.
Dubuque	1,458	W	Stone.
Emmet	301	229	Sand and gravel.
Fayette	1,218	1,376	Stone, sand and gravel.
Floyd	610	W	Stone, sand and gravel, clays.
Franklin	W	W	Do.
Fremont	W	W	Stone, sand and gravel.
Greene	305	W	Sand and gravel.
Grundy	W	50	Do.
Guthrie	W	W	Do.
Hamilton	W	W	Sand and gravel, stone.
Hancock	W	W	Stone, sand and gravel, peat.
Hardin	W	3,353	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	W	W	Do.
Howard	W	416	Do.
Humboldt	W	W	Do.
Ida	34	44	Sand and gravel.
Iowa	W	W	Do.
Jackson	W	W	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	258	W	Stone.
Johnson	2,131	W	Stone, sand and gravel.
Jones	3,031	1,374	Do.
Keokuk	W	W	Stone.
Kossuth	W	84	Sand and gravel.
Lee	W	W	Stone, sand and gravel.
Linn	4,243	3,820	Do.
Louisa	W	W	Stone.
Lucas	W	W	Coal.
Lyon	645	13	Sand and gravel.
Madison	W	W	Stone, clays.
Mahaska	W	W	Coal, sand and gravel, stone.
Marrion	W	W	Stone, coal, sand and gravel, gypsum.
Marshall	W	W	Stone, sand and gravel.
Mills	W	W	Stone.
Mitchell	W	W	Stone, sand and gravel.
Monona	495	445	Sand and gravel.
Monroe	W	W	Coal, stone.
Montgomery	W	W	Sand and gravel, stone.
Muscatine	W	W	Do.
O'Brien	247	W	Sand and gravel.
Osceola	W	W	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	279	348	Sand and gravel.
Plymouth	662	961	Do.
Pocahontas	W	W	Stone, sand and gravel.
Polk	W	W	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Iowa, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Poweshiek -----	W	W	Stone.
Sac -----	\$635	\$645	Sand and gravel.
Scott -----	22,384	25,187	Cement, stone, lime, clays, sand and gravel.
Shelby -----	W	W	Sand and gravel.
Sioux -----	1,113	1,257	Do.
Story -----	W	W	Sand and gravel, stone, clays.
Tama -----	W	W	Stone, sand and gravel.
Taylor -----	W	W	Stone.
Union -----	W	W	Do.
Van Buren -----	W	W	Stone, sand and gravel.
Wapello -----	W	W	Sand and gravel, clays, coal.
Warren -----	W	W	Sand and gravel.
Washington -----	W	W	Stone.
Webster -----	W	W	Gypsum, stone, clays, sand and gravel.
Winnebago -----	436	W	Peat, sand and gravel.
Winneshiek -----	W	W	Stone, sand and gravel.
Woodbury -----	202	233	Sand and gravel, clays.
Worth -----	W	W	Stone, sand and gravel, peat.
Wright -----	758	405	Sand and gravel.
Undistributed ² -----	149,704	165,637	
Total ³ -----	195,740	216,027	

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

¹ Calhoun, Ringgold, and Wayne Counties are not listed because no production was reported.

² Includes some 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 Iowa business activity

	1975	1976 P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,301.7	1,335.0	+2.6
Unemployment ----- do-----	70.8	53.0	-25.1
Employment (nonagricultural):			
Mining ----- do-----	2.8	2.7	-3.6
Manufacturing ----- do-----	229.6	231.3	+7
Contract construction ----- do-----	46.5	46.8	+6
Transportation and public utilities ----- do-----	54.7	54.8	+2
Wholesale and retail trade ----- do-----	245.0	252.4	+3.0
Finance, insurance, real estate ----- do-----	47.2	47.5	+6
Services ----- do-----	176.5	182.9	+3.6
Government ----- do-----	190.8	195.3	+2.4
Total nonagricultural employment ----- do-----	993.1	1,013.7	+2.1
Personal income:			
Total ----- millions--	\$16,783	\$17,923	+6.8
Per capita ----- do-----	\$5,867	\$6,245	+6.4
Construction activity:			
Number of private and public residential units authorized -----	14,706	19,448	+32.2
Value of nonresidential construction ----- millions--	\$181.8	\$268.1	+47.5
Value of State road contract awards ----- do-----	\$159.5	\$177.0	+11.0
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,765	1,892	+3.8
Mineral production value:			
Total crude mineral value ----- millions--	\$195.7	\$216.0	+10.4
Value per capita, resident population ----- do-----	\$68	\$75	+10.3
Value per square mile ----- do-----	\$3,477	\$3,838	+10.4

P Preliminary.

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

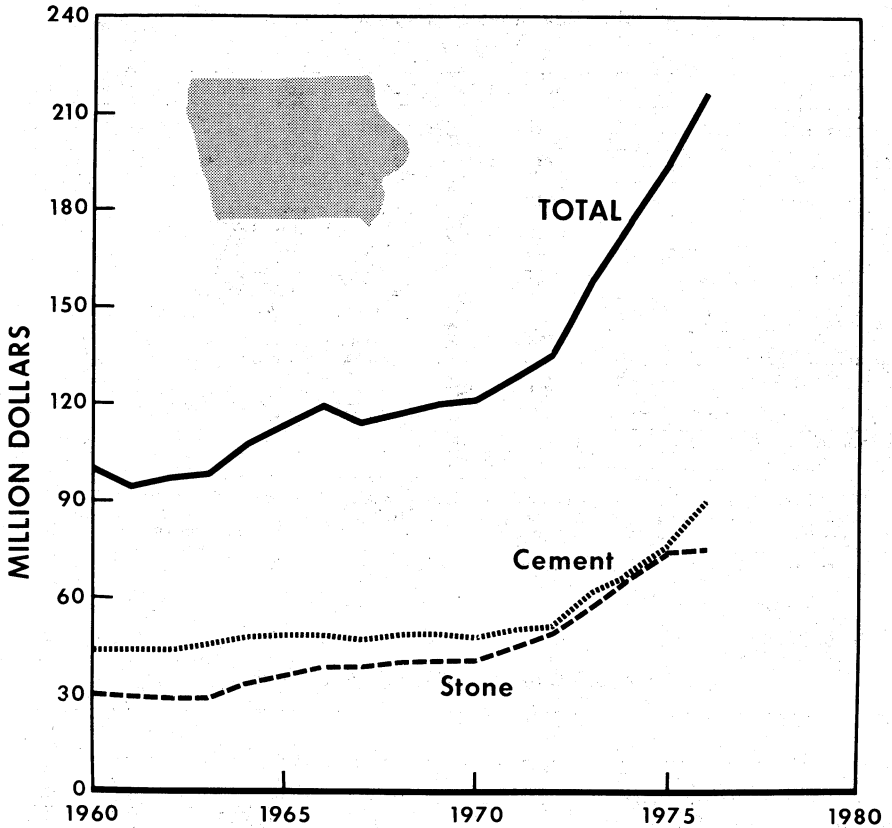


Figure 1.—Value of cement, stone, and total value of mineral production in Iowa.

Safety and Environment.—Iowa, with 506 active surface mines and 13 underground mines, had a disabling-injury frequency rate of 23.43 for underground mines and 15.76 for surface mines. One fatal accident was reported.

Portland Cement Association presented safety awards to Martin Marietta Corp.'s Buffalo plant for 15 years with no disabling injuries and Northwestern States Portland Cement Co.'s Mason City plant for 8 years with no disabling injuries.

The Iowa Limestone Producers Association continued to be interested in improving the public image of the quarry industry by again sponsoring its Quarry Beautification Contest. Alpha Crushed Stone, Inc., was the 1976 grand prize recipient.

Dust control came to the fore when the Iowa Air Quality Commission reminded counties that they were responsible for dust conditions on gravel roads. The reminder resulted from a claim by a local resident that excessive dust conditions were caused by truck traffic from a nearby quarry. Iowa Department of Transportation officials reported that there was 69,809 miles of rock-covered roads in the State.

Legislation and Government Programs.—The Energy and Mineral Resources Research Institute (EMRRI) at Iowa State University, in response to the need for ready access to Iowa statute law governing mining, developed the *Handbook of Iowa Mining Statutes*. This handbook contains every section or chapter of the Iowa Code relating to mining—coal or

otherwise—as well as a subject index to these provisions.

The EMRRI published a report entitled "Legislative Regulation of the Environmental Impact of Strip Mining," which compared proposed Federal legislation with active State legislation concerned with the control of the environmental impact of strip mining. The report attempts to illustrate the best measures to mitigate environmental damage.

The Iowa Geological Survey (IGS), in cooperation with the U.S. Geological Survey (USGS), is attempting to completely map the State on 7.5-minute maps by 1980. The job was nearly 60% completed in 1976.

A new list and index of publications of the IGS was issued. The following impor-

tant publications were released in 1976: (1) Educational Series 3: "A Regional Guide to Iowa Landforms"; (2) Report of Investigations 11: "Gravity Survey of the Randalia Magnetic Anomaly in Fayette County, Iowa"; (3) Technical Information Series I: "A Thermal Model for the Surface Temperature of Materials on the Earth's Surface"; (4) Technical Information Series 2: "Summary of ADP Drillhole Information, Part I: Northeast Iowa"; (5) Technical Information Series 3: "A Late Glacial Pollen Sequence from Northeast Iowa: Sumner Bog Revisited"; (6) Technical Information Series 4: "Land Use in Iowa"; and (7) Miscellaneous Map Series 5: "Land Use in Iowa."

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Portland cement shipments increased approximately 8% over that of 1975 but were still about 10% less than the 1973 record high production. Value of portland cement sold increased 17% over that of 1975 and was 45% higher than that of 1973. The average value of 1 ton of finished portland cement was \$35.32.

Five companies operating 8 wet-process and 10 dry-process kilns, with a maximum capacity of over 3 million tons per year, produced 2.5 million tons of cement. Northwestern States Portland Cement Co. expanded its capacity 37% with the addition of a 500-foot-long by 15-foot-diameter dry-process kiln costing approximately \$24 million.

Over 75% of the cement was shipped from Iowa plants by truck, with about 25% by rail and only a very minor amount by barge.

Prepared masonry cement was produced by Northwestern States Portland Cement Co. at Mason City, Marquette Cement Manufacturing Co. at Des Moines, and Martin Marietta Corp. at Buffalo. Production increases were noted at each of the three plants. Total production increased 23% over that of 1975, with a total value increase of 41%.

A \$25 million modernization and expansion program at Lehigh Portland Cement

Co.'s Mason City plant was announced during the year. The modernization included a 13- by 184-foot kiln with four stage-suspension preheaters and calciner with a rated capacity of 500,000 tons per year.

The kiln and precalciner will be coal-fired and will replace six natural-gas-fired kilns, which have a total capacity of 365,000 tons. These six kilns, along with a waste heat, power-generating system activated by the kilns, will be dismantled. Lehigh will continue to operate one 11.5-foot by 400-foot gas-fired kiln installed in 1958.

Clays.—Clay production was up approximately 6% over that of 1975. This was largely due to increased clay requirements of the cement industry, which accounted for approximately 48% of the clay consumed. Face brick manufacture accounted for 20%, and clay and drain tile manufacturing for 15% of the clay consumption. Clay is also used in the production of lightweight aggregate, sewer pipe, roofing tile, and flue lining. A noticeable decrease in tonnage consumed by sewer pipe and drain tile manufacturers can be attributed to the competition from plastic pipe substitutes.

Gypsum.—Iowa gypsum production increased 23% during the year. United States Gypsum Co. continued to operate an underground mine near Sperry in Des Moines County and a surface mine at Fort Dodge in Webster County. National Gypsum Co.,

Georgia-Pacific Corp., and The Celotex Corp. also operated open pit mines at Fort Dodge. Each of the companies calcined a substantial portion of the gypsum at plants near the mines. Kaser Construction Co. produced gypsum at Harvey in Marion County from a dual-product underground mine. Gypsum was produced from the 200-foot level and limestone from the 400-foot level. Kaser also has a pellet plant for mixing and pelletizing ground limestone and gypsum for soil conditioner.

Lime.—Linwood Stone Products Co. in Scott County continued to be Iowa's only producer of lime.

Perlite.—National Gypsum Co. and United States Gypsum Co. continued to operate perlite expansion plants in Webster County. The expanded perlite was used as lightweight plaster aggregate.

Sand and Gravel.—Sand and gravel production remained virtually unchanged. The production of sand exceeded the production of gravel, with 53% of the total being sand and 47% being gravel. Concrete and asphaltic concrete aggregate were the prin-

cipal uses for sand and gravel, followed by roadbase and coverings, fill, and concrete products, such as cement blocks, bricks, and pipe. The average value for all construction sand and gravel used or sold was \$1.73 per ton.

Fifty percent of the sand and gravel was produced by 7 companies with 64 operations; the other 50% was produced by 111 companies and city and county highway departments with 148 operations. Eighty-three producers with production of less than 100,000 tons each accounted for 17% of the total production.

Stone.—W. C. Weber Stone Co. and W. Becker & Sons Stone Co. quarried dimension limestone for dressed construction stone, house stone veneer, rubble, and other uses. Crushed limestone was quarried by 70 companies at 314 quarries for surface treatment aggregates, roadbase aggregate, roadstone, and other uses. Crushed stone output was 30.3 million tons valued at \$75.9 million. Leading producers were Martin Marietta Corp., Kaser Construction Co., and B. L. Anderson, Inc.

Table 4.—Iowa: Sand and gravel sold or used by producers, by county¹
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Benton	2	W	W	3	140	232
Black Hawk	6	357	833	6	141	277
Boone	10	1,233	1,460	7	374	569
Bremer	3	20	26	2	W	W
Buena Vista	3	110	48	2	W	W
Butler	2	W	W	1	20	14
Carroll	5	276	524	6	271	504
Cerro Gordo	4	301	482	3	149	257
Cherokee	5	216	402	6	361	652
Chickasaw	1	11	18	1	21	42
Clay	5	179	176	5	185	160
Clayton	4	236	929	3	222	960
Clinton	4	192	362	5	844	625
Dallas	6	355	498	5	359	401
Davis	1	60	150	1	70	190
Dickinson	5	148	219	5	239	388
Emmet	3	191	301	3	163	229
Fayette	5	71	96	5	57	72
Franklin	5	W	W	4	244	347
Greene	6	235	305	6	W	W
Grundy	1	13	27	1	18	50
Hamilton	3	196	247	3	318	646
Hancock	7	145	209	7	W	W
Hardin	10	421	485	7	275	272
Howard	2	W	W	1	16	30
Ida	1	20	34	1	56	44
Jones	4	68	142	5	77	132
Kossuth	2	W	W	3	108	84
Lee	1	152	302	2	W	W
Linn	3	684	1,614	4	482	966
Lyon	5	443	645	3	11	13
Marion	4	181	324	4	272	482
Marshall	6	364	579	3	293	496
Muscatine	3	511	782	4	598	1,199
O'Brien	4	197	247	2	W	W
Palo Alto	1	162	279	1	181	348
Plymouth	5	515	662	4	578	961
Pocahontas	1	120	68	1	113	89
Polk	3	800	1,788	5	1,276	2,641
Sac	4	411	635	3	350	645
Stoux	7	646	1,113	6	693	1,257
Webster	7	233	395	3	117	151
Woodbury	3	65	149	3	142	155
Worth	4	170	295	2	W	W
Wright	6	561	758	4	279	405
Undistributed ²	52	4,140	8,236	51	5,092	9,342
Total ³	234	15,410	26,844	212	15,206	26,277

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

¹ Excludes industrial sand and gravel (1976).

² Includes Allamakee, Appanoose, Buchanan, Cedar, Crawford, Delaware, Des Moines, Floyd, Fremont, Guthrie, Harrison, Henry, Humboldt, Iowa, Jackson, Jasper, Johnson, Mahaska, Mitchell, Monona, Montgomery, Osceola, Page, Scott, Shelby, Story, Tama, Van Buren, Wapello, Warren, Winnebago, and Winneshiek Counties, and counties indicated by symbol W.

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

Table 5.—Iowa: Construction aggregate (blended sand and gravel) sold or used commercially by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential construction --	4,013	8,956	3,816	7,949
Highway and bridge construction -----	402	687	320	708
Other construction (dams, waterworks, airports, etc.) -----	162	270	61	106
Concrete products (cement blocks, bricks, pipe, etc.) -----	791	1,608	1,222	2,685
Bituminous paving (asphalt and tar paving) ----	1,465	3,057	1,878	3,695
Roadbase and subbase -----	549	1,000	386	702
Fill -----	525	695	520	947
Other -----	54	122	57	142
Unprocessed:				
Roadbase and subbase -----	103	179	14	17
Fill -----	526	579	608	657
Other -----	W	W	W	W
Total ¹ -----	8,591	17,154	8,882	17,557

W Withheld to avoid disclosing company proprietary data; included with "Nonresidential and residential construction."

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

Table 6.—Iowa: Construction aggregate (blended sand and gravel) sold or used for publicly funded projects by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential construction --	157	306	122	283
Highway and bridge construction -----	1,886	3,989	1,077	2,495
Other construction (dams, waterworks, airports, etc.) -----	61	112	60	127
Concrete products (cement blocks, bricks, pipe, etc.) -----	69	171	157	235
Bituminous paving (asphalt and tar paving) ----	1,492	1,951	989	1,606
Roadbase and subbase -----	2,840	2,765	2,452	2,908
Fill -----	141	188	482	462
Other -----	120	160	229	264
Unprocessed:				
Roadbase and subbase -----	9	8	686	269
Fill and other -----	43	40	71	70
Total -----	6,818	9,690	6,325	¹ 8,720

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

Table 7.—Iowa: Crushed limestone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Allamakee	13	187	391	11	W	W
Benton	1	30	65	6	452	956
Buchanan	13	298	542	17	365	771
Butler	4	W	W	6	139	295
Cedar	1	W	W	6	350	726
Cerro Gordo	7	1,958	3,219	7	2,306	4,110
Clayton	22	508	831	21	504	874
Clinton	10	W	W	10	654	1,579
Delaware	12	445	942	14	492	1,087
Dubuque	15	791	1,458	13	749	1,351
Fayette	16	695	1,122	16	752	1,304
Franklin	5	425	1,346	5	454	992
Fremont	3	W	W	2	103	W
Hardin	3	W	W	3	539	3,081
Henry	1	W	W	1	138	138
Howard	9	152	358	10	173	386
Jackson	5	258	459	7	312	662
Jasper	1	W	W	1	95	W
Jones	29	1,340	2,839	9	423	856
Linn	8	1,101	2,629	10	1,167	2,854
Madison	10	2,126	6,450	10	2,209	6,647
Mahaska	2	W	W	1	14	W
Mills	1	W	W	2	130	W
Monroe	1	W	W	1	260	W
Montgomery	2	W	W	2	263	W
Scott	7	2,050	4,392	4	2,251	4,079
Van Buren	4	474	1,246	5	464	1,460
Webster	3	520	1,350	2	W	W
Winneshiak	20	500	939	14	470	1,029
Worth	3	W	W	5	449	1,261
Undistributed ¹	106	16,476	43,052	94	13,593	39,421
Total ²	337	30,336	73,732	315	30,272	75,921

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

¹Includes Adair, Adams, Allamakee (1976), Appanoose, Black Hawk, Bremer, Cass, Chickasaw, Clarke, Davis, Decatur, Des Moines, Floyd, Grundy (1975), Hamilton, Hancock, Harrison, Humboldt, Jefferson, Johnson, Keokuk, Lee, Louisa, Marion, Marshall, Mitchell, Muscatine, Page, Pocahontas, Pottawattamie, Poweshiek, Story, Tama (1976), Taylor, Union, and Washington Counties and counties indicated by symbol W.

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

Table 8.—Iowa: Crushed limestone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate	3,731	9,968	1,469	3,791
Concrete aggregate	3,905	11,307	3,330	10,582
Dense-graded roadbase stone	6,787	15,504	4,942	11,545
Macadam aggregate	151	382	80	144
Surface-treatment aggregate	5,673	12,700	5,706	14,772
Other construction aggregate and roadstone	1,253	2,729	4,717	10,216
Agricultural limestone ¹	3,265	8,189	4,363	13,182
Cement manufacture	3,268	6,208	3,721	7,436
Riprap and jetty stone	320	747	176	554
Railroad ballast	1,078	2,195	W	W
Other uses ²	886	3,395	1,716	3,700
Total ³	30,323	73,324	30,272	75,921

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

¹Includes soil conditioners, poultry grit, and mineral food.

²Includes railroad ballast (1976), filter stone, lime manufacture, flux stone, asphalt filler, and fill.

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

MINERAL FUELS

Coal (Bituminous).—Coal production decreased less than 1% during the year, but higher unit prices increased the value about 21%. Iowa mines supply less than 7% of the coal used by the State with Wyoming and Illinois supplying 41% and 36%, respectively. Over 82% of the coal was consumed by utilities for electricity generation.

The State of Iowa, at its demonstration

mine 7 miles southwest of Oskaloosa, produced 61,000 tons. The mine, which began producing coal in 1975 as part of the Iowa Coal Research Project, was operated to show that coal can be mined and that the land can be reclaimed in an economically sound and environmentally acceptable manner to an equal or higher agricultural use. Mining at this site is scheduled for completion in 1977.

Table 9.—Iowa: Bituminous coal production in 1976, by type of mine and county

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Underground	Surface	Underground	Surface	
Lucas	1	--	W	--	W
Mahaska	--	5	--	254	\$3,965
Marion	--	4	--	51	718
Monroe	1	--	W	--	W
Wapello	--	1	--	2	W
Total ¹	2	10	309	307	8,351

W Withheld to avoid disclosing company proprietary data; included in "Total."

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

The Iowa Energy Policy Council (EPC) recommended continuation of the project, which was an experiment in mining high-sulfur coal and refining it to meet the low-sulfur environmental standard. The EPC recommended \$2.155 million to operate a demonstration mine. Critics questioned the value of the project.

The EPC and the Iowa Department of Environmental Quality seemed, at times, to run counter to each other as one attempted to encourage burning more Iowa coal and the other wanted tight controls over sulfur oxide emission.

Another phase of the Iowa Coal Research Project involved the construction and operation of a demonstration coal-cleaning plant. The plant, which was located at Ames and dedicated in May 1976, tested coals from various Iowa mines to demonstrate the potential for sulfur removal. The plant has a capability of cleaning approximately 70 tons per hour. Cleaned coal from the plant was burned in the Iowa State University powerplant. Coal-cleaning and refining research continued into 1977.

IGS continued to seek and more clearly determine the quantity and quality of coal available in the State. In its current project,

measured coal reserves were set at 3.5 billion tons. Through a widely spaced drilling hole pattern and a sophisticated analyses procedure, the Survey has estimated that coal resources are in excess of 8 billion tons.

IGS's Coal Exploration Program in southeastern Iowa was received with much interest by coal companies looking for reserves. A list of drill logs, prepared as the exploration program progressed, was made available to the interested public.

Peat.—Colby Pioneer Peat Co. and Eli Colby Co. continued to produce shredded peat in Worth and Winnebago Counties, respectively. Cinagro, Inc., began producing kiln-dried peat in Hancock County.

Energy.—Iowa residents opposed the construction of a high-voltage line across the Mississippi River at Lansing. Power company specialists claimed an alternate route would result in a power loss equal to the power produced by 4,200 tons of coal and would cost about 60% more to construct than the proposed line.

The Iowa Commerce Commission chairman requested a study to determine whether the State needed all the gas and electric utilities and power co-ops it now

has. The State now is served by 7 investor-owned utilities, 67 rural electric cooperatives, and more than 80 municipal utilities.

Iowa Power and Light Co.'s proposal for

a nuclear powerplant in central Iowa brought a major campaign by consumer groups against the proposal. The proposal was still being considered at yearend.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Lehigh Portland Cement Co. ¹	Young Bldg. 718 Hamilton St. Allentown, Pa. 18105	Plant -----	Cerro Gordo.
Marquette Cement Manufacturing Co. ^{1,2}	First American Center Nashville, Tenn. 37238	----do -----	Polk.
Martin Marietta Corp. ^{1,2,3}	11300 Rockville Pike Rockville, Md. 20852	----do -----	Scott.
Northwestern States Portland Cement Co. ^{1,2}	12 Second St., NE. Mason City, Iowa 50401	----do -----	Cerro Gordo.
Penn-Dixie Cement Corp. ²	60 East 42d St. New York, N.Y. 10017	----do -----	Polk.
Clays:			
Can-Tex Industries, Div. of Harsco.	101 Ashworth Rd. Des Moines, Iowa 50265	Pits and plants ---	Cerro Gordo, Dallas, Keokuk, Mahaska, Polk, Wapello.
Carter-Waters Corp -----	2440 Pennway Kansas City, Mo. 64100	----do -----	Appanoose.
W. S. Dickey Clay Manufacturing Co.	Box 6 Pittsburgh, Kans. 66762	----do -----	Webster.
Sioux City Brick & Tile --	504 F St. Sergeant Bluff, Iowa 51054	----do -----	Dallas and Woodbury.
Coal (bituminous):			
Big Ben Coal Co -----	Route 3 Chariton, Iowa 50049	Underground mine.	Lucas.
Lovilia Coal Co -----	Route 2 Melrose, Iowa 52569	----do -----	Monroe.
Star Coal Co -----	802 Lincoln St. Pella, Iowa 50219	Strip mines -----	Mahaska.
Ferrous alloys:			
Foot Mineral Co -----	320 Concert St. Keokuk, Iowa 52632	Plant -----	Lee.
Gypsum:			
The Celotex Corp -----	1500 North Dale Mabry Tampa, Fla. 33607	Pit and plant ----	Webster.
Georgia-Pacific Corp -----	900 Southwest Fifth Ave. Portland, Oreg. 97204	----do -----	Do.
National Gypsum Co. ⁴ ----	325 Delaware Ave. Buffalo, N.Y. 14202	----do -----	Do.
United States Gypsum Co. ⁴	101 South Wacker Dr. Chicago, Ill. 60606	Mines and plant --	Des Moines and Webster.
Lime:			
Linwood Stone Products Co. ³	Route 2 Davenport, Iowa 52804	Plant -----	Scott.
Peat:			
Colby Pioneer Peat Co ----	Box 8 Hanlontown, Iowa 50444	Bog and plant ----	Worth.
Eli Colby Co -----	Box 248 Lake Mills, Iowa 50450	----do -----	Winnebago.
Sand and gravel:			
Acme Aggregates -----	Route 1, Box 210 Comanche, Iowa 52730	Pit and plant ----	Clinton.
Acme Fuel & Materials ----	Box 34 Muscatine, Iowa 52761	----do -----	Muscatine.
L. G. Everist, Inc -----	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	----do -----	Plymouth and Sioux.
G. A. Finley, Inc -----	Harlan, Iowa 51537	----do -----	Crawford, Montgomery, Page, Shelby.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Hallett Construction Co. ²	Box 13 Boone, Iowa 50086	Pit and plant	Boone, Carroll, Cerro Gordo, Cherokee, Franklin, Fremont, Hamilton, Iowa, Marshall, Sac, Story.
Maudlin Construction Co	Box 134 Webster City, Iowa 50595	-----do-----	Boone, Buena Vista, Cerro Gordo, Cherokee, Clay, Franklin, Hamilton, Hardin, Kossuth, Lyon, Marshall, Osceola, Plymouth, Polk, Sac, Story, Warren, Woodbury, Worth, Wright.
West Des Moines Sand Co.	Box 98 W. Des Moines, Iowa 50265	-----do-----	Polk.
Stone:			
Alpha Crushed Stone, Inc.	Box 267 Marion, Iowa 52302	Quarries and plants.	Cedar, Clinton, Jones, Linn.
B. L. Anderson, Inc	327 Guaranty Bldg. Cedar Rapids, Iowa 52400	-----do-----	Benton, Buchanan, Cedar, Jackson, Jones, Linn, Tama.
Kaser Construction Co	3111 Ingersol Des Moines, Iowa 50312	-----do-----	Des Moines, Fremont, Jasper, Keokuk, Mahaska, Marion, Mills, Monroe, Mont- gomery, Poweshiek, Washington.
Medusa Aggregates Co. ³	Box 1085 Burlington, Iowa 52601	-----do-----	Des Moines, Jefferson, Lee, Van Buren.
Schildberg Construction Co., Inc.	Box 358 Greenfield, Iowa 50849	-----do-----	Adair, Adams, Case, Madi- son, Potta- wattamie, Union.
Weaver Construction Co	Box 817 Iowa Falls, Iowa 50126	-----do-----	Cerro Gordo, Franklin, Hamilton, Hardin.
Welp & McCarten, Inc. ³	522 South 22d St. Fort Dodge, Iowa 50501	-----do-----	Black Hawk, Cerro Gordo, Hancock, Howard, Humboldt, Webster, Worth.
Wendling Quarries, Inc	Atalissa, Iowa 52720	-----do-----	Cedar, Delaware, Dubuque, Muscatine.

¹ Also clays.² Also stone.³ Also sand and gravel.⁴ Also expanded perlite.

The Mineral Industry of Kansas

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of Kansas for collecting information on all minerals except fuels.

By Robert B. McDougal¹ and Carol Zarley²

Kansas mineral production value reached a record \$1,213.9 million in 1976, an increase of 25% above the 1975 value of \$970.6 million. The significant rise in the natural gas value accounted for 84% of the overall increase.

Mineral fuels—petroleum, natural gas, natural gas liquids, and coal—historically have accounted for the greater portion of the dollar output and in 1976 this share rose to 85% from 83.7% the preceding year. Except for a decrease in the value of petro-

leum, fuels showed increases in value above those of 1975 ranging from nearly 16% for liquefied petroleum gases to 161.3% for crude helium. Kansas ranked eighth among the petroleum producing States, fifth in natural gas production, and fifth in natural gas liquids output. The value of nonmetallic minerals increased by 15.3%.

¹ State Liaison Officer, Bureau of Mines, Topeka, Kans.

² Mineral economist, State Geological Survey of Kansas, Lawrence, Kans.

Table 1.—Mineral production in Kansas¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ----- thousand short tons--	57	\$2,311	72	\$3,281
Portland ----- do-----	1,832	55,033	2,005	66,478
Clays ----- do-----	1,178	1,604	² 1,064	² 1,869
Coal (bituminous) ----- do-----	479	9,481	590	11,473
Helium (high purity) ³ ----- million cubic feet--	497	11,928	503	11,066
Natural gas ----- do-----	843,625	145,103	829,170	348,251
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels--	6,295	25,062	6,434	31,017
LP gases ----- do-----	23,563	71,632	23,767	83,422
Petroleum (crude) ----- do-----	59,106	561,508	58,714	557,783
Salt ⁴ ----- thousand short tons--	1,446	31,214	1,310	35,291
Sand and gravel ----- do-----	10,886	13,467	⁵ 12,291	⁵ 14,940
Stone ----- do-----	15,907	35,850	⁶ 16,348	⁶ 38,228
Value of items that cannot be disclosed:				
Clays (bentonite, 1976), diatomite, gypsum, helium (crude), lime, pumice (1975), salt (brine), sand and gravel (industrial, 1976), and stone (dimension, 1976) -----	XX	6,418	XX	10,754
Total -----	XX	970,611	XX	1,213,853
Total 1967 constant dollars -----	XX	384,071	XX	^P 346,380

^P Preliminary. XX Not applicable.

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

² Excludes bentonite.

³ Helium measured at 14.7 pounds per square inch absolute at 70° F.

⁴ Excludes salt in brines; value included with "Value of items that cannot be disclosed."

⁵ Excludes industrial sand and gravel, value included with "Value of items that cannot be disclosed."

⁶ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Kansas, by county^{1,2}

(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Allen	W	\$16,975	Cement, stone, clays, natural gas.
Anderson	W	W	Stone.
Atchison	W	W	Do.
Barber	\$9,940	14,824	Petroleum, natural gas, gypsum, natural gas liquids, sand and gravel.
Barton	28,075	28,378	Petroleum, sand and gravel, natural gas, clays.
Bourbon	W	W	Coal, stone.
Butler	W	W	Petroleum, stone.
Chase	441	311	Stone, petroleum, natural gas, sand and gravel.
Chautauqua	W	W	Stone, natural gas.
Cherokee	W	W	Sand and gravel, stone, clays, coal.
Cheyenne	W	W	Sand and gravel, petroleum.
Clark	837	1,876	Natural gas, petroleum, sand and gravel.
Clay	W	W	Sand and gravel, stone.
Cloud	W	W	Clays, sand and gravel, stone.
Coffey	400	1,146	Stone.
Comanche	1,466	2,447	Natural gas, petroleum, sand and gravel.
Cowley	19,283	21,444	Petroleum, natural gas, stone, sand and gravel.
Crawford	W	W	Coal, stone, clays.
Decatur	W	W	Petroleum, sand and gravel.
Dickinson	942	951	Stone, sand and gravel, petroleum.
Doniphan	W	W	Stone, sand and gravel.
Douglas	W	W	Do.
Edwards	2,564	3,597	Petroleum, natural gas, sand and gravel.
Elk	1,847	W	Stone, natural gas.
Ellis	W	W	Petroleum, sand and gravel, stone.
Ellsworth	47,891	52,994	Natural gas liquids, petroleum, salt, natural gas, clays, sand and gravel.
Finney	13,595	11,942	Petroleum, natural gas liquids, sand and gravel, natural gas.
Ford	846	1,575	Natural gas, natural gas liquids, sand and gravel, petroleum.
Franklin	W	W	Stone, clays, natural gas.
Geary	W	W	Sand and gravel, stone.
Gove	6,156	W	Petroleum, sand and gravel.
Graham	25,070	W	Do.
Grant	W	W	Natural gas liquids, helium (high purity), petroleum, helium (crude), sand and gravel.
Gray	40	W	Sand and gravel, petroleum.
Greeley	3	3	Sand and gravel.
Greenwood	W	W	Petroleum, stone, sand and gravel.
Hamilton	1,136	3,528	Natural gas, petroleum, sand and gravel.
Harper	4,228	4,648	Natural gas liquids, petroleum, natural gas, sand and gravel.
Harvey	W	W	Petroleum, natural gas, sand and gravel.
Haskell	12,030	12,181	Do.
Hodgeman	10,439	9,905	Petroleum, sand and gravel.
Jackson	W	W	Stone.
Jefferson	W	1,137	Do.
Jewell	1,615	1,659	Do.
Johnson	W	W	Stone, sand and gravel.
Kearny	2,159	3,427	Petroleum, natural gas liquids, sand and gravel.
Kingman	22,817	23,990	Petroleum, natural gas liquids, natural gas, sand and gravel.
Kiowa	8,239	9,235	Petroleum, natural gas, sand and gravel.
Labette	841	889	Stone.
Lane	3,835	3,436	Petroleum, sand and gravel.
Leavenworth	W	W	Stone, natural gas.
Lincoln	W	W	Stone, sand and gravel.
Linn	757	489	Stone.
Logan	1,648	W	Petroleum.
Lyon	W	W	Petroleum, stone, sand and gravel.
McPherson	14,386	14,209	Petroleum, clays, natural gas, sand and gravel.
Marion	W	W	Petroleum, stone, natural gas.
Marshall	W	W	Gypsum, sand and gravel, stone.
Meade	5,256	6,870	Natural gas, petroleum, sand and gravel.
Miami	482	532	Stone.
Mitchell	24	26	Sand and gravel.
Montgomery	W	W	Cement, stone, clays, natural gas.
Morris	W	W	Petroleum, stone, sand and gravel.
Morton	29,712	37,571	Petroleum, natural gas, helium (high purity), natural gas liquids, sand and gravel.
Nemaha	W	W	Stone.
Neosho	W	W	Cement, stone, clays, sand and gravel.
Ness	26,901	25,740	Petroleum, sand and gravel.
Norton	W	W	Do.
Osage	266	231	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Kansas, by county ^{1 2}—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Osborne -----	W	W	Petroleum.
Ottawa -----	\$2	\$5	Sand and gravel.
Pawnee -----	5,648	6,078	Petroleum, natural gas, sand and gravel.
Phillips -----	W	W	Petroleum, stone, sand and gravel.
Pottawatomie -----	W	W	Stone, petroleum, sand and gravel.
Pratt -----	W	W	Petroleum, natural gas, sand and gravel.
Rawlins -----	W	W	Petroleum, sand and gravel.
Reno -----	W	33,490	Salt, petroleum, sand and gravel, natural gas.
Republic -----	W	W	Sand and gravel.
Rice -----	36,501	37,710	Petroleum, salt, helium (crude), stone, natural gas, sand and gravel.
Riley -----	W	W	Stone, petroleum, sand and gravel.
Rooks -----	28,703	W	Petroleum, sand and gravel.
Rush -----	W	W	Petroleum, helium (high purity), natural gas.
Russell -----	45,658	W	Petroleum, sand and gravel.
Saline -----	W	W	Do.
Scott -----	9,052	9,827	Natural gas liquids, petroleum, natural gas.
Sedgewick -----	W	W	Petroleum, natural gas liquids, sand and gravel, salt.
Seward -----	17,978	26,209	Natural gas liquids, petroleum, natural gas, sand and gravel.
Shawnee -----	W	W	Stone, sand and gravel.
Sheridan -----	W	W	Petroleum, sand and gravel.
Sherman -----	W	W	Petroleum, lime, sand and gravel.
Smith -----	--	W	Stone.
Stafford -----	W	W	Petroleum, natural gas, sand and gravel.
Stanton -----	127	194	Natural gas, petroleum.
Stevens -----	2,994	3,160	Petroleum, natural gas, sand and gravel.
Sumner -----	W	W	Do.
Thomas -----	1,217	W	Petroleum, sand and gravel.
Trego -----	5,896	W	Do.
Wabaunsee -----	W	W	Petroleum, stone.
Wallace -----	W	W	Diatomite, sand and gravel.
Washington -----	W	W	Stone, sand and gravel.
Wichita -----	W	W	Sand and gravel.
Wilson -----	W	13,692	Cement, stone, clays, coal, natural gas.
Woodson -----	W	233	Stone.
Wyandotte -----	W	20,882	Cement, sand and gravel, stone.
Undistributed ³ -----	510,675	744,152	
Total ⁴ -----	970,611	1,213,853	

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

¹ Brown County is not listed because no production was reported.

² Values of petroleum and natural gas are based on average prices per barrel and cubic foot, respectively, for the State.

³ Includes some petroleum and natural gas that cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of Kansas business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands..	1,038.6	1,086.0	+4.6
Unemployment ----- do.....	46.5	46.0	-1.1
Employment (nonagricultural):			
Mining ----- do.....	10.3	10.7	+3.9
Manufacturing ----- do.....	164.2	164.8	+4
Contract construction ----- do.....	38.8	41.9	+8.0
Transportation and public utilities ----- do.....	55.8	56.4	+1.1
Wholesale and retail trade ----- do.....	192.7	203.7	+5.7
Finance, insurance, real estate ----- do.....	38.4	40.2	+4.7
Services ----- do.....	132.3	141.5	+7.0
Government ----- do.....	168.7	171.6	+1.7
Total nonagricultural employment ----- do.....	801.2	830.8	+3.7
Personal income:			
Total ----- millions..	\$13,587	\$14,945	+10.0
Per capita ----- do.....	\$5,959	\$6,469	+8.6
Construction activity:			
Number of private and public residential units authorized ----- do.....	12,106	15,717	+29.8
Value of nonresidential construction ----- millions..	\$169.9	\$192.0	+13.0
Value of State road contract awards ----- do.....	\$125.2	\$161.9	+29.3
Shipments of portland and masonry cement to and within the State ----- thousand short tons..	1,148	1,263	+10.0
Mineral production value:			
Total crude mineral value ----- millions..	\$970.6	\$1,213.9	+25.1
Value per capita, resident population ----- do.....	\$426	\$525	+23.2
Value per square mile ----- do.....	\$11,799	\$14,755	+25.1

^P Preliminary.

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

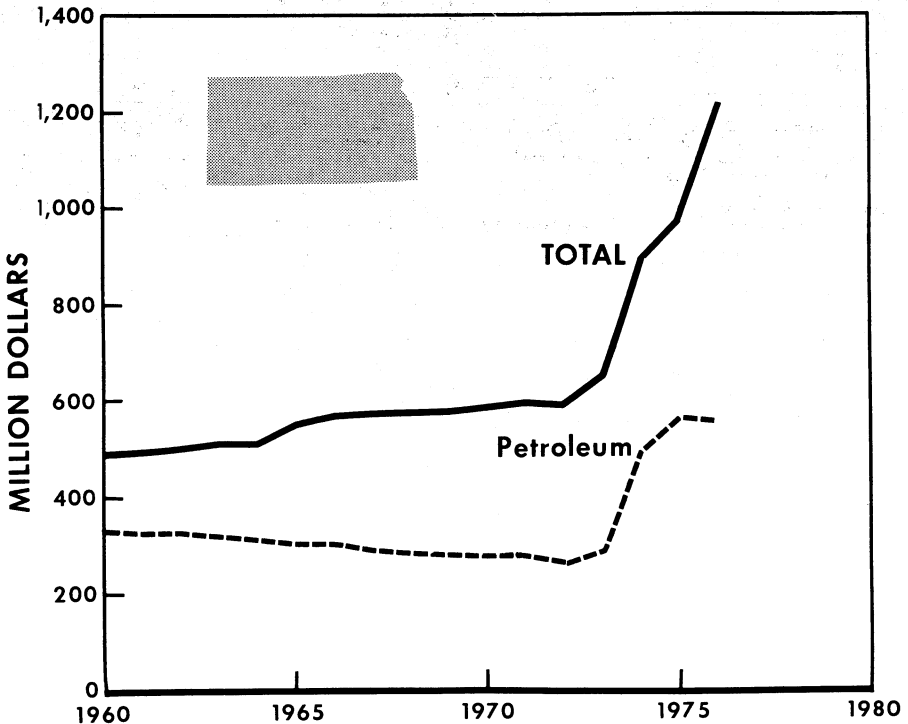


Figure 1.—Value of petroleum and total value of mineral production in Kansas.

Trends and Developments.—An engineering feasibility study for converting an unused salt mine at Lyons in Ellsworth County to a storage place for brine used in the petroleum industry was initiated by MAPCO, Inc., in December.

Construction continued throughout the year at the Jeffrey Energy Center, 7 miles northwest of St. Marys in Pottawatomie County, where Kansas Power & Light Co. and other owners are building a \$1 billion, 2,800-megawatt (Mw), coal-fired electric generating plant to serve 1 million people. Its four 700-Mw units are to become operational in 1978, 1980, 1982, and 1984.

Construction of the LaCygne unit No. 2 powerplant neared completion. Located in Linn County, the new 630,000-kilowatt unit will burn nearly 1,800,000 tons of Wyoming coal annually. The plant is owned by Kansas City Power and Light Co. (KCP&L) and Kansas Gas and Electric Co. (KG&E).

KCP&L and KG&E asked the Nuclear Regulatory Commission (NRC) to permit an estimated \$22.7 million for preliminary work on the proposed Wolf Creek generating station, whether or not the proposed plant near Burlington would operate using uranium or some other fuel. The two utilities, in a joint statement, said that the permit would allow them to build access roads and warehouse facilities, move and construct utility lines, and build a 12-mile railroad spur. On August 13, the NRC announced a moratorium on work authorizations, construction permits, and operating licenses for nuclear plants but indicated it would consider exemptions to the ban. This ban was subsequently lifted on October 26, and the NRC issued an interim rule allowing limited construction.

The Energy Policy and Conservation Act, enacted in December 1975, stipulated a rollback in the average price of domestic crude oil to \$7.66 per barrel (effective February 1976). It contained provisions for a possible annual inflation-incentive increase of 10% until the scheduled price decontrol in early 1979. The legislated rollback had the effect of regulating previously uncontrolled oil at an initial average price of \$11.28 per barrel, while leaving the \$5.25 lower tier price intact. In mid-August 1976, the Energy Conservation and Production Act removed controls from stripper well production effective September 1, 1976, and by yearend the price had risen to an average

of \$14 per barrel. The deregulation of stripper oil has been especially important to Kansas. Nationally, stripper wells comprise 73% of total domestic oil wells, but account for only 14% of domestic production. In Kansas, the percentage of stripper wells is much higher, about 95%, and the contribution to total production substantially greater at nearly 76% of production. Of the five leading stripper States—Kansas, Texas, Oklahoma, Illinois, and New Mexico—Kansas is the only State whose average daily stripper production per well is below the 2.93-barrel U.S. stripper average.

The Kansas Department of Transportation awarded highway improvement contracts totaling \$140.9 million in 1976. This represented a gain of 35.5% from 1975 improvement contracts of \$104.0 million and included construction of interstate and primary State highways, county secondary roads and bridges, as well as maintenance of these facilities. Interstate and primary State highway contracts were \$114.0 million or 81% of the total; county project contracts totaled \$11.2 million; and city projects were \$10.6 million. Highway maintenance resurfacing projects were let on 975 miles of highway during 1976. Safety project contracts totaled \$5.1 million.

There has been no lead-zinc mining in Kansas since 1969. Exploration, centered in Labette County just west of the old tristate district, continued at a modest pace.

Employment.—The Employment Division, Kansas Department of Human Resources (formerly the Kansas Department of Labor), reported a total employment of 10,900 persons in the mining and crude petroleum and natural gas industries in 1976. This represents a modest gain from the 10,300 (revised) employed in these industries the previous year. The oil and gas industry employed 9,200 persons in 1976, up from 8,600 in 1975. Employment during 1976 in the coal and other mining sectors amounted to about 350 and 1,350, respectively.

Statistics prepared by the Division of Workers' Compensation, Kansas Department of Human Resources, show a total of 899 injuries in the mining and crude petroleum industries compared with 948 injuries during 1975. Seven fatalities occurred in 1976 compared with six during the previous year.

Table 4.—Kansas: Injuries, fatalities, and occupational disease in the mineral industry in 1976

Industry	Injuries			Fatalities	Occupational disease	
	Lost time	No lost time	Total		Lost time	No lost time
Bituminous coal and lignite -----	6	--	6	--	--	--
Crude petroleum and natural gas ---	578	130	708	6	--	1
Nonmetallic mining and quarrying -	78	46	124	1	--	--
Other mining -----	38	23	61	--	--	--
Total -----	700	199	899	7	--	1

Source: Division of Workers' Compensation, Kansas Department of Human Resources.

Legislation and Government Programs.—Topographic mapping of approximately 80% of Kansas was completed by yearend, the Kansas Geological Survey announced. Prepared on a scale of 2.6 inches per mile, some 1,220 maps had been completed. The series requires 1,525 topographic maps to cover the State.

An evaluation of the State's coal reserves by the Kansas Geological Survey prepared under a grant from the Federal Bureau of Mines was released.³ Bituminous coal reserves for strip mining in the demonstrated reliability class totaled 998 million tons under less than 100 feet of overburden, and 526 million tons with an overburden to coal thickness ratio of 30:1 or less. In addition, there were 1,816 million tons of inferred reserves under 100 feet of overburden and 794 million tons of inferred coal with a 30:1 or less thickness ratio. These reserve figures were for coal having a minimum thickness of 12 inches.

Early in the year, the State Senate defeated a bill which would have given Energy Transportation Systems, Inc., eminent domain authority to construct a coal slurry pipeline across Kansas. The pipeline would transport coal slurry from Wyoming diagonally across Kansas from Rawlins County southeastward to Sumner County to a proposed electrical generating plant near Little Rock, Ark.

Salt water flushing of Cities Service Oil Co.'s tertiary oil recovery project at the El Dorado field in Butler County began June 1. A cooperative effort with the U.S. Energy Research and Development Administration (ERDA), the project is to determine whether commercial tertiary oil recovery can be obtained using micellar-polymer flooding. If successful, the project could

recover up to 330,000 barrels of crude oil from the 6,200-acre reservoir situated 650 feet below the surface. The injection process will require four fluid slugs injected in sequence: A salinity adjustment or preflush, a micellar fluid to reduce interfacial tension to allow the oil and water to mix, a mobility control fluid polymer to keep the micellar slug together and reduce viscous fingering of the drive water, and the injection of the drive water to move the chemicals and oil to a production well. About the middle of 1978, 15 months after the micellar injection, the \$9 million project should produce oil.

A pilot survey of Kansas was completed in June by ERDA to determine whether the State has significant supplies of uranium. It was part of ERDA's systematic survey of the Nation's surface waters, ground waters, and stream sediments. One goal of the 2-year study is to assist private uranium exploration efforts by furnishing information that will identify favorable exploration areas.

The Kansas Geological Survey received a \$102,000 grant from the NRC for an expanded study of the sources of earthquakes in Kansas. The grant funds the first year of a \$519,000 5-year research project. Attention will be focused on the Nemaha Uplift, a deeply buried ridge of Precambrian granite extending through eastern Nebraska, Kansas, and Oklahoma. Similar research on the ridge will be conducted by the geological surveys of Nebraska and Oklahoma. The purpose of the study was to relate past

³ Brady, L. L., D. B. Adams, and N. D. Livingston. An Evaluation of the Strippable Coal Reserves in Kansas. Kansas Geological Survey Mineral Resources Series 5, 1976. Prepared for the U.S. Department of the Interior, Bureau of Mines (Final Report on Grant No. G0254009).

earthquakes to specific fault zones and to estimate earthquake risk for various parts of the region. The study will aid the NRC in developing siting and design standards for nuclear powerplants in the area. The information will be used by the U.S. Army

Corps of Engineers in construction of dams. These structures must be designed to withstand the largest earthquake that might be expected to occur at the site during the planned lifetime of the structure.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—The Columbian Carbon Co., a subsidiary of Cities Service Co. and the sole producer of carbon black in Kansas, continued production at its Hickok plant in Grant County. Principal uses of carbon black are rubber compounding, inks, and paint.

Coal (Bituminous).—Output of coal derived from six strip mines in 1976 totaled 590,000 short tons, with a total value of \$11.5 million and an average value of \$19.45 per short ton. Production for 1975 from four operating strip mines was 479,000 tons with a value of \$9.5 million and an average value of \$19.79 per ton.

One new company, Bradbury Bros. Coal Co., began strip mining coal in southeastern Bourbon County in 1976.

At the end of 1976, there were six coal mines in operation in the State: Two each in Bourbon and Crawford Counties and one each in Cherokee and Wilson Counties.

Helium.—A total of 503 million cubic feet of high-purity helium valued at \$11.1 million was produced at plants in Grant, Morton, and Rush Counties in 1976. Crude helium, produced in Grant and Rice Counties, increased significantly from that of 1975.

Natural Gas.—Reported gross withdrawals of natural gas were 831,664 million cubic feet, a 1.7% drop from that of 1975.

Of this production, 127,467 million cubic feet was extracted from oil; the remaining 704,197 million cubic feet came from nonassociated natural gas. Marketed natural gas totaled 829,170 million cubic feet in 1976, compared with 843,625 million cubic feet in 1975. Natural gas value rose sharply to \$348.3 million in 1976 from the 1975 value of \$145.1 million. Average wellhead value increased from 17.2 cents per thousand cubic feet to 42.0 cents per thousand cubic feet.

In 1976 there were about 9,330 producing gas wells in the State's approximately 399 fields. Almost 43% of Kansas' gas wells (3,986) were located in the Hugoton gasfield. Fifteen wells were completed in the field during the year. Drilling continued to increase the size of the Panoma gasfield with 195 additional wells, bringing the field's total to 1,198.

Table 5.—Kansas: Natural gas production by major fields
(Million cubic feet)

Field	1975	1976
Glick	15,536	16,739
Greenwood	27,805	25,170
Hugoton	591,128	562,925
Panoma	78,763	98,383
Spivey-Grabs-Basil	19,876	15,784
Other fields	110,517	110,169
Total	843,625	829,170

Source: Kansas Corporation Commission.

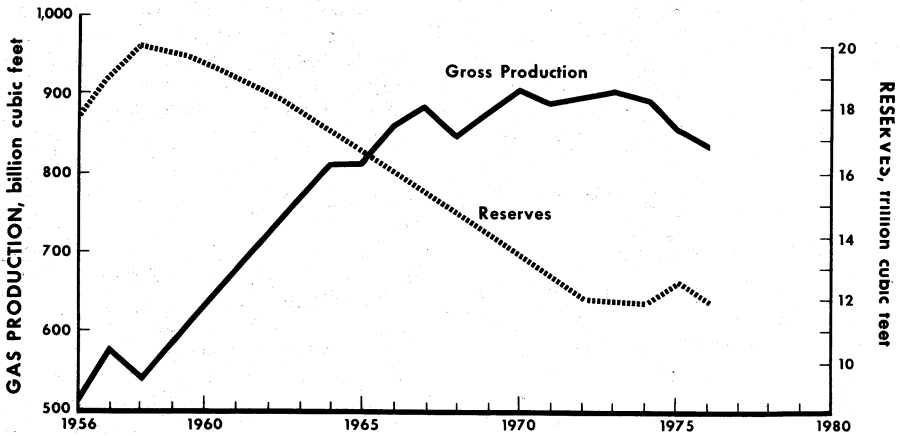


Figure 2.—Natural gas production and reserves in Kansas, 1956-76.

The quantity of natural gas in millions of cubic feet delivered to consumers was as follows:

Consumer	1975	1976
Residential -----	98,372	101,330
Commercial -----	48,714	55,640
Industrial, including refinery fuel and carbon black production -----	124,378	140,116
Electric utilities -----	127,818	122,366
Others -----	2,991	1,870

The American Gas Association (AGA) reported that natural gas reserves totaled 11,951 billion cubic feet at yearend, a decrease of 711 billion cubic feet from the 1975 reserves. According to AGA, revisions and extensions totaled 97 billion cubic feet. The ultimate recovery of natural gas as estimated to December 31, 1976, was 35,311 billion cubic feet. Associated dissolved natural gas amounted to 3,384 billion cubic feet and accounted for almost 10% of total ultimate recovery; for nonassociated natural gas the figures were 31,927 billion cubic feet, or over 90%. There were 18 underground natural gas storage reservoirs containing 172.5 million cubic feet on December 31, 1976.

Natural Gas Liquids.—The Kansas Corporation Commission reported that 29 operating gas processing plants produced 30,201,000 barrels of natural gas liquids including ethane in 1976. The 1976 output

rose 1.1% from the 29,858,000 barrels produced in 1975. Liquid petroleum gas accounted for 3,682,000 barrels, ethane accounted for 6,430,000 barrels, and plant condensate accounted for 4,000 barrels. Kansas, the fifth largest producing State, accounted for 5% of the U.S. total.

Total value rose to \$114,439,000 from \$96,694,000 in 1975. The average price per barrel in 1976 for liquefied petroleum gas and ethane was \$3.51, an increase of 47 cents over 1975. The average price of natural gasoline and cycle products increased to \$4.82 from \$3.98 in 1975, and the plant condensate price per barrel declined to \$5.92 from the 1975 price of \$6.13.

Proved reserves of natural gas liquids at yearend 1976, as estimated by AGA, totaled 388,078,000 barrels. Nonassociated reserves totaled 378,902,000 barrels and associated dissolved reserves totaled 9,176,000 barrels. Revisions and extensions resulted in a minus 2,732,000 barrels to reserves, whereas new fields and new reservoirs in old fields added 591,000 barrels. The reserves in 1976 represent a decrease of 28,951,000 barrels when compared with reserves totaling 417,029,000 barrels at the end of 1975.

Petroleum.—Crude oil output in Kansas was reported to be 58,714,000 barrels in 1976. Value of the petroleum produced in

the Nation's eighth largest producing State was \$557.8 million in 1976 and represented nearly 46% of the total mineral production value. The average unit value remained at \$9.50 per barrel.

The five leading counties and their production in thousand barrels were as follows: Russell, 4,838; Ellis, 4,615; Barton, 2,924; Rooks, 2,880; and Ness, 2,700. Output from these counties totaled 17,956,658 barrels, or nearly 31% of the State's production. Gray County became the 86th Kansas county to report the production of oil. Production was established by Gear Oil Co.

The two leading producing fields with annual production in excess of 1 million barrels were Bemis-Shutts and Hall-Gurney. Their combined production accounted for 5.7% of the State's output.

Estimated proved crude oil reserves on December 31, 1976, were 361,570,000 barrels, according to the American Petroleum Institute, a decrease of 2,824,000 barrels from that of 1975. New fields and pools added oil reserves of 5,225,000 barrels compared with 6,467,000 barrels in 1975. Revisions and extensions added 50,907,000 barrels, compared with 21,696,000 barrels in 1975.

Table 6.—Kansas: Crude oil production, indicated demand, and stocks in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within Kansas
January -----	5,052	5,085	5,438
February -----	4,362	4,405	5,395
March -----	5,131	4,719	5,807
April -----	4,780	4,826	5,761
May -----	4,948	4,786	5,973
June -----	4,997	6,196	4,774
July -----	4,985	4,398	5,361
August -----	4,936	5,614	4,683
September -----	4,932	4,944	4,671
October -----	4,820	4,689	4,802
November -----	4,856	4,540	5,118
December -----	4,915	4,803	5,230
1976 total -----	58,714	58,905	XX
1975 total -----	59,106	59,879	XX

XX Not applicable.

Table 7.—Kansas: Crude oil production in 1976, by county
(Thousand 42-gallon barrels)

County	Production
Barber	634
Barton	2,924
Butler	2,433
Chase	3
Cheyenne	38
Clark	86
Comanche	46
Cowley	2,091
Decatur	492
Dickinson	5
Edwards	187
Ellis	4,615
Ellsworth	691
Finney	1,102
Ford	13
Gove	715
Graham	2,381
Grant	183
Gray	4
Greenwood	1,468
Hamilton	12
Harper	201
Harvey	271
Haskell	1,184
Hodgeman	1,042
Kearny	261
Kingman	1,933
Kiowa	675
Lane	360
Logan	319
Lyon	233
Marion	352
McPherson	1,442
Meade	314
Morris	230
Morton	1,863
Ness	2,700
Norton	257
Osbome	28
Pawnee	491
Phillips	1,498
Pottawatomie	20
Pratt	655
Rawlins	675
Reno	809
Rice	2,424
Riley	77
Rooks	2,880
Rush	480
Russell	4,838
Saline	181
Scott	144
Sedgwick	532
Seward	624
Sheridan	275
Sherman	23
Stafford	2,439
Stanton	8
Stevens	173
Sumner	1,312
Thomas	210
Trego	601
Wabaunsee	244
Miscellaneous eastern Kansas stripper counties	e 3,313
Total	58,714

^e Estimate.

Source: Kansas Corporation Commission.

Studies at the Kansas Geological Survey⁴ show that 18,701,313 barrels (32%) of the State's 1975 production was recovered from

Table 8.—Kansas: Crude petroleum production, by field
(Thousand 42-gallon barrels)

Field	1975	1976	Cumulative to Dec. 31, 1976
Bemis-Shutts	1,878	1,822	222,108
Chase-Silica	1,120	1,120	252,669
El Dorado	1,056	1,093	282,081
Hall-Gurney	1,612	1,521	130,377
Kraft-Prusa	845	803	119,472
Trapp	1,326	1,307	209,656
Other fields	51,269	51,048	NA
Total	59,106	58,714	NA

NA Not available.

Source: Oil and Gas Journal data adjusted to Bureau of Mines total.

1,400 enhanced recovery projects in 69 counties; however, only 12,108,726 barrels (20.6%) were reported as production resulting directly from the injected fluid. Some operators reported total oil produced from projects, but did not indicate the amount attributable to enhanced recovery methods. Of the 1975 projects, the number and types used were: 1 fireflood; 113 pressure maintenance; 294 dump floods; 660 waterflood operations; and 332 not identified. In 1976, 19,061,004 barrels (32%) of the State's output was recovered from 1,454 enhanced recovery projects, but only 11,939,142 barrels (20.3%) was reported as production resulting directly from the injected fluids. It is believed that the higher total (19,061,004 barrels) more accurately represents oil produced by secondary and tertiary methods in Kansas. The number and types of projects used during 1976 were 1 miscible flood, 3 firefloods, 261 dump floods, 371 pressure maintenance, 678 waterfloods, and 140 not identified.

Drilling Activities.—In 1976, industry drilled 3,707 wells for oil and gas, 648 more wells than were drilled in 1975. Development wells totaled 2,793 and exploratory wells reached 914; 2,013 resulted in oil or gas recovery and 1,694 were dry. Drilling activity brought forward 1,473 new oil wells and 540 gas wells. Forty-eight percent of the development wells were completed as oil wells and 18% of the development wells

⁴ Oros, M. O. and D. K. Saile. Enhanced Oil Recovery Operations in Kansas, 1975. Kansas Geol. Survey Energy Resources Series 7, 1976; Enhanced Oil Recovery Operations in Kansas, 1976. Kansas Geol. Survey Energy Resources Series 9, 1977.

were completed as gas wells; dry wells accounted for the remaining 34%. Total development and exploratory drilling footage increased from 10,014,049 feet in 1975 to 11,394,507 feet in 1976, a 13.8% gain. Oil well completions rose sharply by 35% in

1976 to 1,473 out of 3,707 total test wells for oil and gas.

Barton, Cowley, Ellis, Greenwood, Ness, and Russell Counties accounted for 22.5% of all well completions in 1976. Footage drilled in these counties totaled 2,759,251 feet, an average of 3,312 feet per well.

Table 9.—Kansas: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Allen	62	1	28	--	--	2	93	78,079
Anderson	50	2	8	1	--	8	69	67,048
Barber	26	15	31	6	1	11	90	414,262
Barton	48	3	51	6	3	15	126	413,485
Bourbon	15	--	12	--	--	--	27	19,787
Butler	57	--	33	2	--	11	103	273,399
Chase	--	2	4	--	1	10	17	25,726
Chautauqua	40	1	26	1	--	4	72	102,123
Cherokee	--	1	--	--	--	--	1	720
Cheyenne	3	1	2	1	1	7	15	64,060
Clark	4	7	12	4	2	15	44	237,280
Cloud	--	--	--	--	--	2	2	5,561
Coffey	19	--	24	6	1	22	72	133,392
Comanche	1	9	5	--	1	11	27	136,074
Cowley	100	4	29	6	--	23	162	503,410
Crawford	4	3	2	--	1	2	12	4,686
Decatur	10	--	12	3	--	14	39	148,719
Dickinson	--	--	--	--	--	4	4	10,512
Douglas	1	--	--	--	--	--	1	906
Edwards	3	12	11	--	4	4	34	144,272
Elk	31	--	8	1	--	4	44	74,426
Ellis	47	--	44	5	--	17	113	420,038
Ellsworth	12	4	9	2	--	8	35	107,480
Finney	8	17	4	1	--	5	35	131,129
Ford	--	--	3	--	--	5	8	34,360
Franklin	9	1	13	--	--	3	26	23,610
Gove	10	--	6	2	--	20	38	157,852
Graham	15	--	26	12	--	26	79	303,454
Grant	--	42	3	--	--	1	46	159,173
Gray	--	--	--	1	--	5	6	27,047
Greeley	--	13	5	--	1	2	21	63,039
Greenwood	69	--	29	2	--	21	121	255,045
Hamilton	--	28	1	--	1	1	31	87,465
Harper	16	12	13	2	2	14	59	260,407
Harvey	6	7	13	1	--	4	31	93,405
Haskell	5	17	--	--	1	1	24	86,205
Hodgeman	7	--	9	2	--	38	56	251,814
Jackson	--	--	--	--	--	3	3	11,239
Jefferson	--	--	--	--	--	1	1	1,950
Johnson	3	1	3	--	--	--	7	5,554
Kearny	10	78	7	2	2	5	104	352,920
Kerny	10	78	7	2	2	5	104	389,817
Kingman	11	23	37	1	5	17	94	389,817
Kiowa	5	2	15	--	2	9	33	160,753
Labette	1	2	5	--	--	--	8	6,097
Lane	6	--	6	5	--	20	37	168,269
Leavenworth	--	1	--	--	--	1	2	3,845
Linn	11	--	5	2	--	3	16	8,577
Logan	5	--	5	2	--	7	19	88,088
Lyon	27	1	10	1	--	10	49	117,872
McPherson	27	9	21	1	3	11	72	213,365
Marion	18	1	10	--	--	10	39	98,499
Meade	3	3	8	1	--	9	24	136,262
Miami	26	1	9	--	--	3	39	24,891
Mitchell	--	--	--	--	--	1	1	3,079
Montgomery	77	1	18	--	1	1	98	92,448
Morris	2	--	1	--	--	2	5	11,419
Morton	3	37	2	1	1	4	48	158,782
Nemaha	--	--	--	--	--	1	1	3,975
Neosho	55	2	23	--	--	--	80	54,748
Ness	41	--	51	17	--	40	149	654,542
Norton	5	--	--	1	--	1	7	23,692

See footnotes at end of table.

Table 9.—Kansas: Oil and gas well drilling completions in 1976, by county—Continued

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Osage	--	--	--	--	--	2	2	4,498
Osborne	--	--	--	--	--	5	5	14,338
Pawnee	5	10	6	2	1	10	34	118,408
Phillips	10	--	5	--	--	--	15	51,603
Pottawatomie	2	--	1	--	--	3	6	17,929
Pratt	7	12	13	3	2	11	48	183,178
Rawlins	13	--	10	2	--	13	38	164,179
Reno	3	6	10	2	--	13	34	119,041
Rice	14	30	14	--	1	6	65	156,680
Rooks	23	--	19	6	--	13	61	216,180
Rush	7	7	21	1	--	12	48	180,668
Russell	106	--	46	3	--	7	162	512,731
Saline	--	--	1	--	--	3	3	8,184
Scott	3	2	1	2	2	17	27	112,763
Sedgwick	--	--	3	--	--	9	12	41,454
Seward	4	15	12	1	1	7	40	207,206
Sheridan	3	--	5	1	--	17	26	98,388
Sherman	2	--	--	--	--	2	4	15,827
Smith	--	8	--	--	1	1	1	203
Stafford	23	--	24	2	1	12	70	273,846
Stanton	--	13	3	--	--	1	17	50,416
Stevens	1	23	--	--	--	1	25	86,157
Sumner	24	1	13	3	--	29	70	240,673
Thomas	1	--	3	4	--	15	23	104,341
Trego	6	--	12	1	--	17	36	145,506
Wabaunsee	--	--	--	--	--	7	7	20,996
Wallace	--	1	--	--	--	2	2	8,180
Wichita	1	1	--	--	4	--	6	20,573
Wilson	27	2	7	--	--	--	36	35,284
Woodson	42	--	21	--	--	2	65	76,996
Total	1,341	494	958	132	46	736	3,707	11,394,507

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Pipeline Mileage.—Beginning January 1, 1974, Kansas had 16,343 (revised) miles of petroleum pipeline in place. Of this aggregate, gathering lines accounted for 6,207 miles; product pipelines, 6,013 (revised) miles; and crude trunk lines, 4,123 miles. For the 3-year period ending January 1, 1977, pipeline mileage laid amounted to 2,147 miles of new pipe and 792 miles of secondhand pipe; 2,130 miles of pipe was taken up. Gathering line mileage increased 193 miles to 6,400 miles, product pipelines increased 741 miles to 6,754 miles, and crude trunk line mileage declined 125 miles to 3,998 miles; the net increase on January 1, 1977, amounted to 809 miles over the total mileage in place on January 1, 1974.

The capacity of all crude oil pipelines on January 1, 1977, reached 4,642,000 barrels, 294,000 barrels more than in 1974; product pipelines increased 276,000 barrels from 1974 to 2,760,000 barrels in 1977.

Skelly Gas Gathering, Inc., purchased an 88-mile pipeline from Anadarko Production

Co. The line delivers gas from the Spivey-Grabs pool to consumers in the Wichita area, Mobil Oil Co.'s refinery at Augusta, and Skelly Oil Co.'s refinery at El Dorado. A 15-mile gathering system in Harper County to deliver gas to the acquired line was constructed.

The completion of Texhoma Pipeline Co.'s 510-mile pipeline from near Freeport, Tex., to Cushing, Okla., early in the year permitted Skelly Oil Co.'s El Dorado refinery to process some 13,000 barrels per day of Libyan crude oil or about 16% of its daily input requirements. From Cushing, Osage Pipeline Co.'s 20-inch pipeline moves the crude to the El Dorado refinery. This important breakthrough came at a time when the refinery had been relying on dwindling Midwest and Canadian crude oil supplies.

Refineries.—Eleven refineries operated in Kansas in 1976 with a throughput capacity of 459,593 barrels per day. Refinery receipts of domestic crude oil totaled 129,010,000

barrels. Crude oil processed at refineries was 145,604,000 barrels in 1976, compared with 141,119,000 barrels in 1975. Intrastate receipts totaled 54,877,000 barrels, of which 52,555,000 barrels were transported to the refineries by pipeline and 2,322,000 barrels by rail tank car and truck. Interstate receipts totaled 74,133,000 barrels: 74,040,000 barrels was transported by pipeline, and 93,000 barrels by rail tank car and truck. Origins of the interstate crude oil receipts were as follows: From Oklahoma, 21,321,000 barrels; Texas, 28,898,000 barrels; Wyoming, 17,945,000 barrels; and 5,969,000 barrels

from other States. Foreign crude oil to Kansas refineries totaled 16,974,000 barrels: From Libya, 10,297,000 barrels; Nigeria, 2,299,000 barrels; Algeria, 976,000 barrels; Saudi Arabia, 915,000 barrels; and 2,487,000 barrels from other countries. Opening stocks totaled 1,607,000 barrels. Closing stocks totaled 1,931,000 barrels, resulting in a positive stock change of 324,000 barrels. Based on total January 1, 1976, capacity, refineries operated at 87.6% of capacity in 1976.

Consumption of fuels by Kansas refineries in 1976 was reported to be as follows:

Fuel	Quantity	Btu equivalent ¹ (billion Btu)
Distillate fuel oil -----thousand barrels--	1	1
Residual fuel oil -----do-----	1,434	9,016
Liquefied petroleum gas -----do-----	337	1,352
Natural gas -----million cubic feet--	28,096	28,967
Refinery gas -----do-----	35,689	35,332
Petroleum coke -----thousand short tons--	441	13,283
Purchased electricity -----million kilowatt-hours--	664	2,266
Total Btu equivalent -----	XX	90,217

XX Not applicable.
¹ Conversion factors: Distillate, 5,825,000 Btu per barrel; residual, 6,287,000 Btu per barrel; LPG, 4,011,000 Btu per barrel; natural gas, 1,031 Btu per cubic foot; refinery gas, 990 Btu per cubic foot; petroleum coke, 30,120 Btu per short ton; purchased electricity, 3,412 Btu per kilowatt-hour.

Kansas' 11 operating refineries had a total throughput of 156,317,000 barrels in 1975, and 158,968,000 barrels in 1976, yielding the following finished petroleum products, in thousand barrels.

	1975	1976
Motor gasoline -----	88,765	91,361
Aviation gasoline -----	366	447
Jet fuel -----	3,708	3,513
Liquefied refinery gas and ethane -----	3,723	4,172
Kerosine -----	386	226
Distillate fuel oil -----	39,726	40,100
Residual fuel oil -----	5,241	5,847
Petrochemical feedstocks -----	379	537
Special naphtha -----	1,033	1,542
Lubricating oil -----	1,243	1,417
Petroleum wax -----	580	694
Petroleum coke -----	4,310	4,023
Asphalt and road oil -----	5,832	5,532
Still gas -----	4,337	4,958
Miscellaneous products -----	194	244
Processing gain -----	-3,506	-5,645

Percent of refinery yields of the major petroleum products from crude and unfinished oil reruns were as follows:

	1975	1976
Gasoline, total ¹ -----	52.9	53.6
Kerosine -----	.3	.2
Jet fuel, total -----	2.6	2.4
Distillate fuel oil -----	27.9	23.1
Residual fuel oil -----	3.7	4.0
All other products -----	12.6	11.7

¹ Based on total gasoline output minus input of natural gas liquids.

Table 10.—Kansas: Capacity of petroleum refineries, Jan. 1, 1977
(Barrels per calendar day)

Company	Location	Operating	Shut-down	Type of process ¹	Crude oil distillation: Cracking, reforming, coking, and alkylation			Other products
					Charge (operating and shut-down)	Gasoline output		
					Operating	Shut-down		
American Petrofina Co. of Texas.	El Dorado	25,000	--	CC	11,500	6,500	--	Asphalt.
				CR	4,500	4,000	--	
				A	2,500	2,000	--	
APCO Oil Corp	Arkansas City.	46,230	--	CC	9,400	6,230	--	Do.
				CR	16,500	14,850	--	
				H	3,000	2,960	--	
CRA, Inc	Coffeyville	48,000	--	A	3,750	2,300	--	Asphalt, coke, lubricants, wax.
				CC	16,000	8,050	--	
				CR	8,600	7,500	--	
Do	Phillipsburg	26,400	--	C	8,500	1,400	--	Asphalt.
				A	6,100	3,500	--	
				CC	8,500	5,600	--	
Derby Refining Co.	Wichita	27,982	--	CR	5,300	4,700	--	Coke.
				C	2,500	1,400	--	
				A	10,200	5,700	--	
E-Z Service, Inc. (Formerly North American Petroleum Corp.).	Shallow Water.	10,000	--	CR	4,800	4,176	--	Asphalt.
				C	3,800	985	--	
				A	4,032	2,782	--	
Mid-America Refining Co., Inc.	Chanute	3,100	--	--	--	--	--	Do.
Mobil Oil Corp	Augusta	50,000	--	CC	19,900	10,500	--	Do.
				CR	20,000	8,200	8,200	
				TC	3,900	1,050	--	
National Cooperative Refinery Association.	McPherson	54,150	--	A	4,729	3,500	--	Coke.
				CC	19,000	11,970	--	
				CR	6,650	5,850	--	
Phillips Petroleum Co.	Kansas City	90,000	--	C	16,150	1,940	--	Asphalt.
				A	9,050	5,700	--	
				CC	32,000	16,000	--	
Skelly Oil Co	El Dorado	78,731	--	CR	16,000	15,000	--	Coke.
				A	11,400	9,000	--	
				CC	29,300	17,700	--	
				CR	20,380	16,540	--	
				C	11,160	2,440	--	
				A	14,100	9,840	--	

¹ CC—catalytic cracking, CR—catalytic reforming, H—hydrocracking, C—coking, TC—thermal cracking, A—alkylation.

NONMETALS

Cement.—Portland cement shipments in 1976 were 2,005,000 short tons, a gain of 9.4% over the 1975 shipments of 1,832,000 tons. The value of portland cement shipments was \$66.5 million, a 21% increase from the 1975 shipments value of \$55.0 million. Drawdowns from stocks accounted for much of the increased shipments. Disposition of portland cement by customer type from plants in Allen, Montgomery, Neosho, Wilson, and Wyandotte Counties was ready-mix concrete, 68%; concrete product manu-

facturers, 8%; building material dealers, 6%; and other uses, 18%.

Table 11.—Kansas: Portland cement salient statistics
(Thousand short tons)

	1975	1976
Number of active plants	5	5
Production	1,835	1,950
Shipments from mills:		
Quantity	1,832	2,005
Value	\$55,033	\$66,478
Stocks at mills, Dec. 31	222	189

Table 12.—Kansas: Masonry cement salient statistics
(Thousand short tons)

	1975	1976
Number of active plants -----	5	5
Production -----	66	70
Shipments from mills:		
Quantity -----	57	72
Value -----	\$2,311	\$3,231
Stocks at mills, Dec. 31 -----	22	18

Clays.—Production of clay and shale fell almost 9.7% in volume, whereas value increased 16.5% from the 1975 figures.

Gypsum.—Crude gypsum was mined by National Gypsum Co. at its mine near Sun City in Barber County and the Bestwall Div., Georgia-Pacific Corp. mine at Blue Rapids in Marshall County. Output was 3.1% greater than the previous record established in 1973. Gypsum, for use in the manufacture of wallboard and other products, was calcined by these companies at their respective plants.

Lime.—The Great Western Sugar Co., in Sherman County, was the State's only lime producer. The entire output was used in sugar refining at the company's Goodland plant. Production and value declined appreciably from 1975.

Perlite.—Crude perlite mined out-of-State was processed by Lite-Weight Products, Inc., at its plant located in Wyandotte County. Major uses for the expanded perlite in 1976 were horticultural aggregates, 47%; and cavity fill and masonry, 19%. Filter aids, plaster aggregate, concrete aggregate,

and other uses accounted for the other 34%.

Salt.—The quantity of salt (excluding brine) produced was 1,310,000 short tons with a value of \$35,291,000 in 1976; this represents over a 9% drop in quantity but a 13% gain in value over that of 1975. Salt was extracted from the Wellington Formation (Lower Permian) by five companies operating in Ellsworth, Reno, and Rice Counties. Evaporated salt was produced by two companies using solution mining techniques; rock salt was produced by one operator through underground mining; and two firms produced both evaporated and rock salt. In Sedgwick County, a sixth company produced salt brine for use in the chemical industry.

Table 13.—Kansas: Evaporated and rock salt sold or used by producers
(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt	
	Quantity	Value	Quantity	Value
1972 ----	723	17,207	646	3,355
1973 ----	782	19,914	615	3,547
1974 ----	778	23,127	589	3,880
1975 ----	771	26,274	675	4,940
1976 ----	785	30,795	525	4,496

Sand and Gravel.—Production from 164 operations increased 13% to 12,291,000 short tons and the value rose to \$14,940,000, an 11% increase above that of 1975. In descending order, leading counties for sand and gravel sold or used were Sedgwick, Wyandotte, Reno, Shawnee, and Barton.

Table 14.—Kansas: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value ¹
Construction:				
Processed:				
Sand -----	7,065	8,068	9,511	11,205
Gravel -----	1,585	2,354	2,780	3,735
Unprocessed:				
Sand and gravel -----	1,975	1,026	(²)	(²)
Total -----	10,625	11,448	12,291	14,940
Industrial:				
Sand and gravel -----	241	856	W	W
Grand total -----	10,866	12,304	³ 12,291	³ 14,940

W Withheld to avoid disclosing company proprietary data.

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in other tables are f.o.b. plant of blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

² "Unprocessed sand and gravel" included under "Construction: Processed."

³ Excludes industrial sand and gravel.

Table 15.—Kansas: Sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	4,491	6,471	4,718	6,444
Concrete products (cement blocks, bricks, pipe, etc.) ----	542	609	443	560
Asphaltic concrete aggregate and other bituminous mixtures -----	1,413	1,760	1,735	2,334
Roadbase and coverings -----	2,134	1,729	2,342	2,321
Fill -----	¹ 1,679	¹ 1,604	1,689	1,932
Other uses -----	367	440	1,363	1,347
Total ² -----	10,625	12,611	12,291	14,940
Industrial sand and gravel -----	241	856	W	W
Grand total -----	10,866	13,467	³ 12,291	³ 14,940

W Withheld to avoid disclosing company proprietary data.

¹ Includes "Unprocessed other" indicated by W in table 15 in the 1975 Kansas chapter.

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

³ Excludes industrial sand and gravel.

Table 16.—Kansas: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Barber -----	1	19	5	2	W	W
Barton -----	6	238	258	7	364	413
Chase -----	1	9	3	1	9	3
Cherokee -----	2	W	W	2	W	W
Cheyenne -----	2	W	W	3	73	127
Clark -----	1	25	18	1	25	17
Clay -----	1	W	W	1	W	W
Cloud -----	2	176	W	1	169	W
Comanche -----	2	32	29	2	27	27
Cowley -----	4	319	373	3	125	175
Decatur -----	1	19	5	1	19	5
Dickinson -----	1	W	W	1	W	W
Douglas -----	2	W	W	2	W	W
Edwards -----	2	W	W	1	W	W
Elk -----	1	5	1	1	W	W
Ellis -----	2	W	149	3	131	229
Ellsworth -----	3	W	W	5	38	23
Finney -----	3	W	W	2	W	W
Ford -----	2	W	W	3	224	364
Geary -----	2	148	239	3	263	302
Gove -----	1	36	9	1	36	9
Graham -----	1	30	7	1	30	7
Grant -----	1	21	23	1	8	4
Gray -----	1	49	40	1	50	42
Greeley -----	1	6	3	1	6	3
Greenwood -----	1	W	W	1	W	W
Hamilton -----	1	3	4	2	23	34
Harper -----	2	W	W	2	W	W
Harvey -----	1	145	W	2	294	W
Haskell -----	1	44	17	1	48	16
Hodgeman -----	4	71	18	2	22	6
Jackson -----	1	7	4	--	--	--
Johnson -----	1	W	W	1	W	W
Kearny -----	3	W	W	3	W	W
Kingman -----	2	W	W	2	W	W
Kiowa -----	1	23	17	2	W	W
Lane -----	1	65	16	1	65	16
Lincoln -----	2	118	40	1	W	W
Linn -----	1	30	66	--	--	--
Logan -----	1	2	4	--	--	--
Lyon -----	1	30	8	1	19	6
McPherson -----	1	5	3	1	5	3
Marshall -----	2	160	331	2	164	366
Meade -----	1	26	24	1	31	31
Mitchell -----	2	31	24	2	27	26

See footnotes at end of table.

Table 16.—Kansas: Sand and gravel sold or used by producers, by county—Continued
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Morris	1	W	W	1	W	W
Morton	1	7	4	1	7	10
Neosho	1	W	W	2	W	W
Ness	1	102	26	1	81	90
Norton	1	11	12	1	W	25
Ottawa	1	9	2	1	17	5
Pawnee	3	94	128	4	150	203
Phillips	2	72	71	2	65	63
Pottawatomie	1	79	107	1	80	142
Pratt	2	W	W	2	W	W
Rawlins	5	25	19	3	9	7
Reno	6	595	587	7	647	720
Republic	1	W	W	1	W	W
Rice	3	W	W	3	W	W
Riley	1	W	W	2	W	W
Rooks	1	15	4	1	15	4
Russell	1	45	40	1	54	50
Saline	2	314	W	3	W	W
Sedgwick	10	2,359	2,968	12	2,634	3,127
Seward	3	181	188	3	142	194
Shawnee	6	512	589	7	612	679
Sheridan	1	15	4	1	15	4
Sherman	1	W	8	4	32	16
Stafford	1	W	W	1	W	W
Stevens	1	81	80	1	82	83
Sumner	1	W	W	1	W	W
Thomas	1	61	86	4	115	112
Trego	2	117	110	2	143	126
Wallace	1	18	24	1	7	10
Washington	1	W	W	1	W	W
Wichita	2	W	W	2	W	W
Wyandotte	8	1,591	2,338	8	1,538	2,414
Other counties	--	2,717	3,831	2	3,549	4,597
Total ¹	149	10,866	13,467	164	² 12,291	² 14,940

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

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

² Excludes industrial sand and gravel.

Stone.—Stone sold or used by producers totaled 16,348,000 short tons in 1976. Crushed limestone comprised 96% of the total. Sixty companies at 198 quarries produced crushed stone. The principal uses

were raw material for cement, concrete aggregate, and dense-graded roadbase stone. Transportation and shipment was by truck, 15,952,000 tons; railroad, 338,000 tons; and waterway, 58,000 tons.

Table 17.—Kansas: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone total	117	1676	W	W
Crushed and broken stone:				
Limestone	15,382	33,704	15,734	36,331
Undistributed ²	508	1,470	614	1,897
Total	15,890	35,174	16,348	38,228
Grand total	15,907	35,850	³ 16,348	³ 38,228

W Withheld to avoid disclosing company proprietary data.

¹ To avoid disclosing company proprietary data, dimension limestone and sandstone are combined.

² Includes sandstone, quartzite, and other stone.

³ Excludes dimension stone.

Table 18.—Kansas: Crushed and broken stone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate	2,128	5,313	2,167	5,527
Concrete aggregate	2,833	7,858	2,722	8,404
Dense-graded roadbase stone	2,473	5,563	2,665	5,990
Macadam aggregate	206	344	236	362
Surface treatment aggregate	1,979	4,558	1,222	3,271
Other construction (aggregate and roadstone)	1,629	2,830	2,549	5,098
Agricultural limestone	694	1,292	864	1,673
Cement manufacture	3,209	6,015	3,317	6,293
Railroad ballast	78	285	W	W
Riprap and jetty stone	415	620	153	363
Other uses ¹	246	496	448	1,247
Total	15,890	35,174	16,348	38,228

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

¹ Includes filter stone, lime manufacture, and uses indicated by symbol W.

Sulfur.—Elemental sulfur was recovered as a byproduct of refining crude petroleum by Skelly Oil Co., Butler County; CRA, Inc., Montgomery County; and Phillips Petroleum Co., Wyandotte County. A total of 7,041 long tons with a value of \$252,544 was sold in 1976, down from the quantity sold in 1975.

Table 19.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co. ^{1,2} ..	1000 Tenmain Center Kansas City, Mo. 64105	Plant and quarry	Neosho.
General Portland, Inc., Victor Div.	7701 East Kellogg St. Wichita, Kans. 67207	----do -----	Wilson.
Lone Star Industries, Inc. ² ..	2511 East 46th St. Indianapolis, Ind. 46205	----do -----	Wyandotte.
The Monarch Cement Co. ^{1,2} ..	Humboldt, Kans. 66748	----do -----	Allen.
United States Steel Corp., Universal Atlas Cement Div. ^{1,2}	600 Grant St. Pittsburgh, Pa. 15230	----do -----	Montgomery.
Clays:			
Acme Brick Co	Box 98 Kanapolis, Kans. 67454	Pit	Ellsworth.
Cloud Ceramics	Box 369 Concordia, Kans. 66901	Pit	Cloud.
W. S. Dickey Clay Manu- facturing Co.	Box 6 Pittsburg, Kans. 66762	Pits and plant ..	Cherokee and Crawford.
Excelsior Clay Products, Inc.	Box 32 Fredonia, Kans. 66736	----do -----	Wilson.
Micro-Lite, Inc	1100 South Katy St. Chanute, Kans. 66720	Pit	Neosho.
Coal (bituminous):			
Bill's Coal Co	5200 South Yale Ave. Tulsa, Okla. 74135	Strip mine -----	Bourbon.
Clemens Coal Co. ¹	Box 92299 Pittsburg, Kans. 66762	----do -----	Crawford.
Diatomite:			
N. L. Industries, Inc., In- dustrial Chemicals Div.	Box 2808 St. Louis, Mo. 63111	Pit and plant ..	Wallace.
Gypsum:			
Georgia-Pacific Corp	900 SW. 5th Ave. Portland, Oreg. 97204	Quarry and plant.	Marshall.
National Gypsum Co	325 Delaware Ave. Buffalo, N.Y. 14202	----do -----	Barber.
Helium:			
Alamo Chemical-Gardner Cryogenics, Inc.	Elkhart, Kans. 67950	Plant	Morton.
Cities Service Helix, Inc ..	Ulysses, Kans. 67880	----do -----	Grant.
Kansas Refined Helium Co ..	Otis, Kans. 67565	----do -----	Rush.
Northern Helix Co	Bushton, Kans. 67427	----do -----	Rice.

See footnotes at end of table.

Table 19.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime:			
The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Plant -----	Sherman.
Natural gas ³ and petroleum: ^{3 4}			
Salt:			
American Salt Corp -----	3142 Broadway Kansas City, Mo. 64111	Wells and under- ground mine.	Rice.
Carey Salt Co -----	1800 Carey Blvd. Hutchinson, Kans. 67501	-----do -----	Reno.
Morton Salt Co -----	110 North Wacker Dr. Chicago, Ill. 60606	Wells -----	Do.
Vulcan Materials Co., Chemical Div.	Box 7689 Birmingham, Ala. 35223	-----do -----	Sedgwick.
Sand and gravel:			
Bingham Sand and Gravel Co.	2005 East Ave. Baxter Springs, Kans. 66713	Pits -----	Cherokee.
Builders Sand Co -----	78th and Holliday Dr. Kansas City, Kans. 66106	Dredge and pits -	Johnson and Wyandotte.
Holliday Sand and Gravel Co.	6811 West 63d St. Overland Park, Kans. 66202	Dredges -----	Douglas and Wyandotte.
Miles Sand, Inc -----	4857 North Meridian Wichita, Kans. 67204	Pit and plant ---	Sedgwick.
Ritchie Sand Co -----	6500 West 21st St. Wichita, Kans. 67204	Dredge -----	Do.
Stone:			
N. R. Hamm Quarries, Inc.	Box 425 Herington, Kans. 67449	Quarries and plants.	Various (15 counties).
Holland Quarries, Inc -----	Box 5283 Lenexa, Kans. 66215	Mines and plants.	Johnson.
Killough-Clark, Inc -----	Box 263 Ottawa, Kans. 66067	Quarries and plants.	Anderson, Franklin, Miami, Osage.
Martin-Marietta Corp -----	11300 Rockville Pike Rockville, Md. 20852	-----do -----	Various (15 counties).
Midwest Minerals, Inc -----	709 North Locust Pittsburg, Kans. 66762	-----do -----	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
Reno Construction Co., Inc.	Box 4278 Overland Park, Kans. 66204	Quarries -----	Coffey, Doug- las, Johnson, Miami.
Sulfur (byproduct):			
CRA, Inc -----	3315 North Oak Trafficway Kansas City, Mo. 64116	Secondary recovery.	Montgomery.
Phillips Petroleum Co -----	Bartlesville, Okla. 74003	-----do -----	Wyandotte.
Skelly Oil Co -----	Box 1650 Tulsa, Okla. 74101	-----do -----	Butler.

¹ Also clays.² Also stone.³ Most of the major oil and gas companies and many smaller companies that operate in Kansas are listed in several commercial directories.⁴ Petroleum refineries in Kansas are listed in table 10.

The Mineral Industry of Kentucky

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Kentucky for collecting and disseminating information on all minerals produced from mines, quarries, and wells.

By William T. Boyd¹ and Preston McGrain²

The value of mineral production in Kentucky increased 14% in 1976 to a total of \$3.11 billion. This increase largely reflects the State's continuing first place in coal production, the fluctuating spot market coal prices, and some increases in unit value of petroleum produced from stripper wells.

During 1976, the coal industry produced 144 million tons of bituminous coal from 2,215 surface and underground operations. This is a slight increase above the record total of 143.6 million tons produced in 1975 and a reduction of nearly 8% in the number of mining operations. These data

indicate that although some large mines were expanding, many small operations were placed on standby or abandoned entirely. Surface mining continued as the dominant mining method for the sixth consecutive year, employing 15,340 workers and producing 79.5 million tons, while 855 underground mines employing 24,153 workers produced about 64.5 million tons of bituminous coal.

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² Assistant state geologist, Geological Survey of Kentucky, University of Kentucky, Lexington, Ky.

Table 1.—Mineral production in Kentucky¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ²thousand short tons..	778	\$1,483	754	\$2,395
Coal (bituminous).....do.....	143,613	2,499,295	143,972	2,848,690
Natural gas.....million cubic feet..	60,511	32,876	66,137	36,375
Petroleum (crude).....thousand 42-gallon barrels..	7,556	54,520	7,488	35,454
Sand and gravel.....thousand short tons..	8,924	14,466	9,154	15,271
Stone.....do.....	31,734	67,906	33,378	77,060
Zinc (recoverable content of ores, etc.).....short tons..	41	32	59	44
Value of items that cannot be disclosed:				
Cement, clays (ball), fluor spar, lead (1975), lime, and natural gas liquids.....	XX	38,481	XX	49,800
Total.....	XX	2,788,859	XX	3,114,589
Total 1967 constant dollars.....	XX	1,083,767	XX	² 1,119,695

² Preliminary. 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Kentucky, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value ²
Adair	W	W	Petroleum, stone.
Allen	W	W	Do.
Anderson	W	W	Stone.
Ballard	\$1	\$2	Sand and gravel.
Barren	W	W	Stone, petroleum.
Bell	W	W	Coal, petroleum.
Boone	W	W	Sand and gravel, stone.
Bourbon	W	W	Stone.
Boyd	W	W	Coal, petroleum.
Boyle	W	W	Stone.
Breathitt	W	W	Coal, petroleum.
Breckinridge	W	W	Stone, petroleum, sand and gravel.
Bullitt	W	W	Stone, clays.
Butler	W	W	Coal, petroleum, s. one.
Caldwell	W	W	Stone.
Calloway	W	W	Sand and gravel.
Carlisle	W	W	Clays, sand and gravel.
Carter	5,962	W	Coal, stone, clays.
Casey	W	W	Stone, petroleum.
Christian	7,529	W	Coal, stone, petroleum.
Clay	20,700	W	Coal, petroleum.
Clinton	W	W	Petroleum, stone.
Crittenden	W	W	Stone, zinc.
Cumberland	W	W	Petroleum, stone.
Davies	W	W	Coal, petroleum, sand and gravel.
Edmonson	W	W	Stone, petroleum.
Elliott	7,329	W	Coal, petroleum.
Estill	W	W	Petroleum, stone.
Fayette	W	W	Stone.
Fleming	W	W	Do.
Floyd	79,187	113,785	Coal, natural gas liquids, petroleum, sand and gravel.
Franklin	W	W	Stone.
Fulton	W	W	Sand and gravel.
Gallatin	310	192	Do.
Garrard	W	W	Stone.
Graves	W	W	Clays, sand and gravel.
Grayson	W	W	Stone, coal, petroleum.
Green	W	W	Petroleum, stone.
Greenup	W	W	Coal, petroleum.
Hancock	W	3,977	Coal, sand and gravel, petroleum, clays.
Hardin	1,534	1,863	Stone.
Harlan	W	W	Coal, stone.
Harrison	W	W	Stone.
Hart	W	W	Stone, sand and gravel, petroleum.
Henderson	W	W	Coal, petroleum, sand and gravel.
Henry	W	W	Stone.
Hickman	1	W	Sand and gravel.
Hopkins	W	W	Coal, petroleum.
Jackson	W	W	Coal, stone.
Jefferson	W	W	Cement, stone, sand and gravel, clays.
Jessamine	W	W	Stone.
Johnson	W	W	Coal, petroleum.
Knott	97,030	W	Do.
Knox	29,777	W	Do.
Laurel	W	W	Coal, stone, petroleum.
Lawrence	14,323	W	Coal, petroleum.
Lee	W	W	Petroleum, coal, stone.
Leslie	W	W	Coal, petroleum.
Letcher	119,445	W	Coal, petroleum, stone.
Lewis	W	W	Clays, sand and gravel.
Livingston	W	W	Stone, fluorspar, sand and gravel.
Logan	W	W	Stone, petroleum.
McCracken	W	W	Sand and gravel.
McCreary	18,548	W	Coal, petroleum.
McLean	13,072	W	Do.
Madison	W	W	Stone.
Magoffin	27,864	W	Coal, petroleum.
Marion	W	W	Stone.
Marshall	W	4,061	Do.
Martin	94,187	W	Coal, sand and gravel, petroleum.
Mason	W	W	Sand and gravel, stone.
Meade	W	W	Natural gas liquids, stone.
Menifee	W	W	Stone, coal.
Mercer	W	W	Stone.
Metcalfe	W	W	Stone, petroleum.
Monroe	W	W	Do.
Montgomery	W	W	Stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Kentucky, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value ²
Morgan	W	W	Coal, stone, petroleum.
Muhlenberg	\$244,629	W	Coal, petroleum, stone.
Nelson	W	W	Stone.
Nicholas	506	\$505	Do.
Ohio	W	W	Coal, stone, petroleum.
Oldham	W	W	Stone, sand and gravel.
Owsley	4,714	W	Coal, petroleum.
Pendleton	W	W	Lime, stone.
Perry	114,901	W	Coal, petroleum.
Pike	520,075	W	Coal, stone, petroleum.
Powell	W	W	Petroleum, stone, clays.
Pulaski	9,470	W	Coal, stone, petroleum.
Rockcastle	W	W	Coal, stone.
Rowan	W	W	Stone, clays.
Russell	W	W	Petroleum.
Scott	W	W	Stone.
Simpson	W	W	Stone, petroleum.
Spencer	W	W	Sand and gravel.
Taylor	W	W	Stone.
Todd	W	W	Stone, petroleum.
Trigg	319	W	Stone.
Trimble	W	W	Sand and gravel.
Union	W	W	Coal, petroleum, sand and gravel.
Warren	1,436	W	Stone, petroleum, coal.
Washington	W	W	Stone.
Wayne	W	W	Coal, stone, petroleum.
Webster	57,410	W	Coal, petroleum.
Whitley	W	W	Coal, clays, petroleum.
Wolfe	W	W	Coal, petroleum, stone.
Undistributed ³	1,248,600	2,990,204	
Total	\$2,738,559	\$3,114,589	

¹ W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² The following counties are not listed because no production was reported: Bath, Bracken, Campbell, Carroll, Clark, Grant, Kenton, Larue, Lincoln, Lyon, Owen, Robertson, Shelby, and Woodford.

³ Values of petroleum and natural gas are based on an average unit value for the State.

⁴ Includes natural gas and values indicated by symbol W.

⁵ Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Kentucky business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	1,408.0	1,448.0	+2.8
Unemployment -----do-----	103.0	81.0	-21.4
Employment (nonagricultural):			
Mining -----do-----	46.6	46.6	--
Manufacturing -----do-----	259.7	271.1	+4.4
Contract construction -----do-----	50.3	54.4	+8.2
Transportation and public utilities -----do-----	60.2	60.5	+5
Wholesale and retail trade -----do-----	222.9	234.6	+5.2
Finance, insurance, real estate -----do-----	41.4	43.1	+4.1
Services -----do-----	168.2	177.0	+5.2
Government -----do-----	215.0	221.6	+3.1
Total nonagricultural employment -----do-----	1,064.3	1,108.9	+4.2
Personal income:			
Total -----millions-----	\$16,499	\$18,439	+11.8
Per capita -----do-----	\$4,871	\$5,379	+10.4
Construction activity:			
Number of private and public residential units authorized -----do-----	10,675	13,402	+25.5
Value of nonresidential construction -----millions--	\$101.0	\$186.8	+85.0
Value of State road contract awards -----do-----	\$183.0	\$371.0	+102.7
Shipments of portland and masonry cement to and within the State -----thousand short tons--	988	1,164	+17.8
Mineral production value:			
Total crude mineral value -----millions--	\$2,738.9	\$3,114.6	+13.7
Value per capita, resident population -----do-----	\$809	\$909	+12.4
Value per square mile -----do-----	\$67,802	\$77,103	+13.7

^p Preliminary.

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

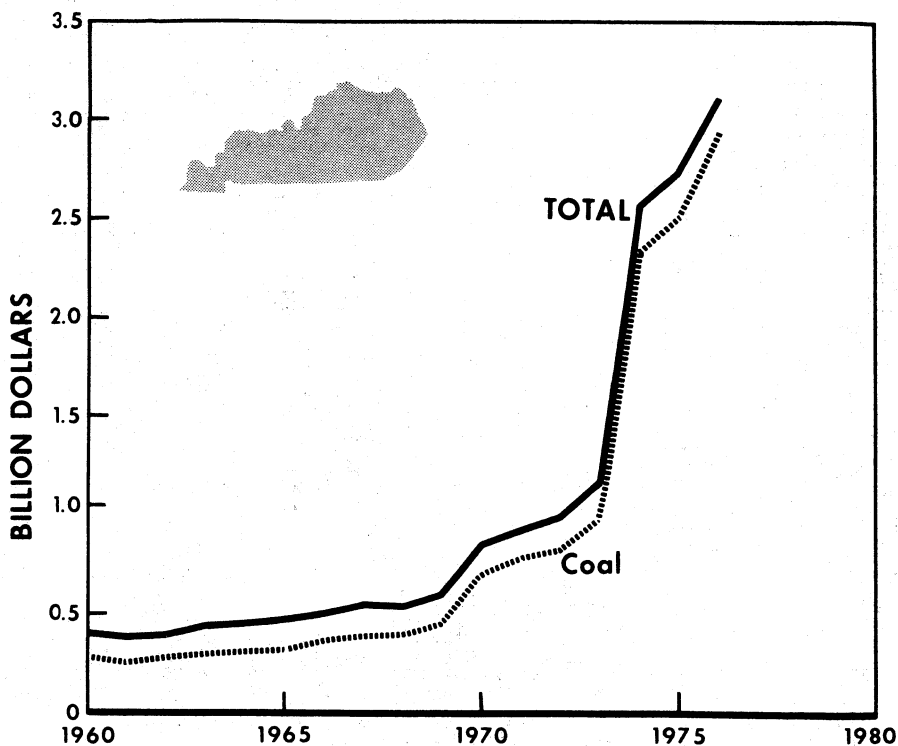


Figure 1.—Value of coal and total value of mineral production in Kentucky.

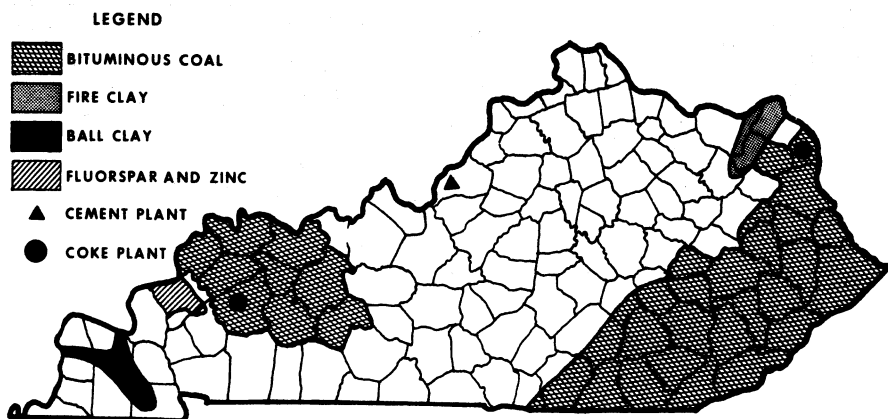


Figure 2.—Mineral resources and mineral industries of Kentucky.

Legislation and Government Programs.—The U.S. Geological Survey and the Geological Survey of Kentucky continued their cooperative geologic mapping program for developing 7.5-minute quadrangle maps for all 120 counties within the State. During the past year, 38 additional 7.5-minute quadrangle maps were published, making a total of 582 maps produced during this program.

The Geological Survey of Kentucky published four reports on geology and mineral resources in selected areas.³

The Federal Bureau of Mines completed field work on the cooperative study with the University of Kentucky and Beth-Elkhorn Coal Corp. on ground control problems related to shortwall recovery of medium-thick coalbeds under deep, mountainous terrain. One phase of the cooperative study with Morehead State University for determining high-stress areas in mountainous terrain has been completed, and the cooperating coal company has revised its mining projections to avoid high-stress areas predicted by this geologic study.

The U.S. Forest Service continued its intensive search for appropriate watersheds in eastern Kentucky for a possible cooperative investigation with the Bureau of Mines and a selected coal company to document water quality changes, stream sedimentation changes, and soil erosion problems directly related to surface mining operations being conducted in a prescribed manner. The cooperative study between the State's Division of Reclamation and the Environmental Protection Agency (EPA) for relating environmental problems in selected areas with nearby surface mining operations continued while another study for evaluating the drain control potentials of selected materials used on surface mine access roads was started during the year. EPA provided funds for a State cooperative study for comparing sedimentation released from undisturbed watersheds before, during, and after surface mining operations using the modified block-cut mining method.

The Federal Bureau of Mines developed a cost-sharing agreement with Leeco, Inc., for demonstrating equipment and techniques for longwall recovery of thin coalbeds. The Tennessee Valley Authority (TVA), under orders from EPA to reduce burning high-sulfur coal, authorized an ex-

penditure of \$4 million for determining the feasibility of using fluidized-bed combustion of these coals without emission of air pollutants. One particular site in Knott County has been evaluated for the planned 200-megawatt plant that will use nearly 740,000 tons of coal annually. TVA also announced plans for construction of the world's largest coal washing facility at its Paradise generating plant in Muhlenberg County. Reportedly, this facility ultimately will cost \$150 million and have an annual operating cost of nearly \$35 million.

The U.S. Department of Energy (DOE) and the University of Kentucky have two research investigations for assessing the natural gas potential of shale deposits within the State and for relating fracture zone patterns with possible gas production. Also, DOE is evaluating three coal gasification proposals from the State. These demonstration plants would provide both heating and cooling energy along with producer gas for an industrial operation. The study sponsored by the National Aeronautics and Space Administration (NASA) for determining the feasibility of using satellite-collected photographs and other data for detecting surface mining disturbances is being continued.

The State reorganized its executive branch to include a Department of Energy for coordinating all energy research efforts by various State agencies. The University of Kentucky organized an Institute of Mining and Minerals Research (IMMR) that will conduct Federal-State contract research on the extraction, transportation, and utilization of fossil fuels and minerals. The recent legislature appropriated \$50 million to be used partially as matching funds for Federal cooperative investigations and the construction of required laboratory facilities in Lexington. IMMR instituted several cooperative research projects on coal gasification, coal liquefaction, new coal

³ Cressman, E. R., and M. C. Noger. Tidal-Flat Carbonate Environments in the High Bridge Group (Middle Ordovician) of Central Kentucky. Ky. Geol. Survey, ser. 10, Rept. Inv. 18, 1976, 15 pp.

Lambert, T. W. Water in a Limestone Terrane in the Bowling Green Area, Warren County, Kentucky. Ky. Geol. Survey, ser. 10, Rept. Inv. 17, 1976, 43 pp.

McGrain, F. Tar Sands (Rock Asphalt) of Kentucky—a Review. Ky. Geol. Survey, Rept. Inv. 19, 1976, 16 pp.

Wilson, E. N., and D. G. Sutton. Oil and Gas Map of Kentucky, Sheet 4, Eastern Part. Ky. Geol. Survey, ser. 10, 1976, 1:250,000.

combustion technology, and provided financial support for many students planning careers in mineral-related fields.

The State made widespread changes in the organization and enforcement of its strip mine regulations. Several additional professional engineers were added to the staff, and salary changes were instituted that should further enhance the recruitment and retention of professional engineers and foresters in this organization.

The State continued the federally funded program for training emergency medical technicians in the coal mining industry. These classes have been conducted principally at Morehead State and Eastern Kentucky Universities in the eastern coalfield and by Western Kentucky University and Madisonville and Murray Community Colleges in the western coalfield.

The State instituted a mandatory program of training for new employees at both surface and underground coal mines and an 8-hour annual refresher training program for all employees. The Department of Mines and Minerals is building a staff of 100 mine safety analysts that will be stationed throughout the State to detect and correct unsafe work habits among miners. Recent court actions require the coal industry to employ more women among the work force. Three coal companies have been fined severely and have agreed to actively recruit additional women until the total work force is about 20% female.

The Department of Mines and Minerals continued sponsorship of the federally funded education and training program being conducted at Morehead State University, Pikeville College, and the community colleges at Cumberland and Madisonville. These programs have provided several hundred technically trained and mine safety-oriented employees to the coal industry. The State vocational training system has instituted a federally funded program for required mine entry training.

Trends and Developments.—Personal income increased 11.8% in 1976 to a record total of \$18,439,000,000. Kentucky had a per capita income of \$5,379 and this ranked 41st nationally compared with the 45th ranking in 1975. Total unemployment decreased 21.4%. Mineral production value and total employment increased substantially as the State retained the lead in

bituminous coal production and was second in the production of ball clay, and second in fluorspar.

During 1976, 12 mineral commodities were produced in Kentucky; 6 were classified as nonmetallic, which showed a 19% gain. Total value of these nonmetallics increased nearly \$20.6 million above the \$107.2 million in 1975. With the gradual improvement in the housing and road building industries, production and unit value of these minerals should improve in the near future. Also, ongoing exploration efforts for delineating the quality and magnitude of zinc deposits in the Cumberland County area should increase the value of these resources within the next 3-5 years.

Environmental problems created by past and present surface mining activities along with air quality problems caused by stack gas emissions from large thermal powerplants continued to receive special attention during the year. The TVA decided to construct a large coal preparation facility at its Paradise plant to reduce atmospheric pollution and widespread crop damage caused by sulfur dioxide emission from this and other nearby coal-burning powerplants.

Fuel resources accounted for about 96% of the total value of all minerals produced in 1976, the same as in 1975. Petroleum production continued to decline, but at a more gradual rate compared with 1974 and 1975 production. This probably reflects continuing production from stripper wells. Natural gas production showed a 9% improvement during the year, and as drilling activity has declined markedly in recent months, this increase indicates a greater production from existing wells.

Bituminous coal production showed a very small increase from the record total of 143.6 million tons produced in 1975. The number of operating mines decreased nearly 8% indicating that many small mines largely supplying spot market coal needs were closed during the year. The unit values of all fossil fuels continued to show slight improvement with the largest increase appearing in the selling price of bituminous coal.

The continuing problems of gondola shortages, deteriorating conditions of both railroad and highway coal haulage systems, along with sporadic labor problems, seriously hampered many mining operations

during the year. The ever-increasing costs of coal extraction and transportation placed a very serious economic burden on this industry and has forced many small and medium-sized operators to either merge with other companies, sell, or abandon their particular operations. The number of coal mines decreased from 2,401 in 1975 to 2,215 in 1976.

The rather widespread interest that developed in 1975 for new oil and gas well drilling continued through 1976. During the year, 1,480 permits were issued to drill, deepen, or reopen old oil and gas wells. This was a 5.8% increase over the number of permits issued in 1975. Most of the new drilling activities were in Green, Cumberland, and Adair Counties, and the leading counties in petroleum production were Union, Lee, Henderson, and Daviess.

The coal mine safety record was rather dismal for the year mainly because of the two explosions in the Scotia mine that killed 23 workmen and 3 Mining Enforce-

ment and Safety Administration mine inspectors and the 17 workers killed at other underground and surface operations. Other than the mine explosion, falls of roof and machinery accidents continued to be the main causes of fatal injuries.

Three of the proposed coal gasification projects were approved for Federal cost sharing. These particular projects will determine the feasibility of using available coal resources to produce low-Btu gas for industrial purposes. Another large coal gasification project was proposed for western Kentucky but this was not supported by Federal funds, mainly because other nearby sites proposed for adjacent States appeared more economical.

The Ashland Coal Co., a subsidiary of Ashland Oil Corp., announced plans for building a coal preparation and barge-loading facility. This operation will be located on a 75-acre site along the Big Sandy River near the confluence of the Ohio and Big Sandy Rivers.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—The severe weather conditions during the first part of the year along with labor problems in the latter months seriously hampered all mining activities, especially those operations in eastern Kentucky. Even with these constraints, however, the coal industry increased production slightly compared with the record production of 143.6 million tons in 1975. The 1976 coal production had a record value of \$2.8 billion for an average of \$19.79 per ton compared with the average value of \$7.73 in 1973, the beginning of the ongoing energy shortage. During 1976, the number of operating mines decreased about 8%, from a total of 2,401 in 1975, indicating a consolidation of many small and medium-sized operations as well as

closure of some marginal operations largely supplying spot market demands. Coal was produced from 44 counties while Muhlenberg and Pike Counties continued to lead in production by producing 20.1 and 19.0 million tons, respectively.

In eastern Kentucky, 2,054 mines operating in 31 counties produced 91.1 million tons, and the previous year, 2,219 mines operating in 31 counties produced 87.3 million tons. Underground coal production at 40.6 million tons was about the same as that in 1975, while surface production increased about 8.5% above the 1975 production of 46.6 million. The number of underground operations decreased nearly 5% from 869 mines in 1975, and the number of surface operations decreased about 9.1% from 1,350 mines in the previous year.

Table 4.—Kentucky: Bituminous coal production, by type of mine and county, 1976
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Under- ground	Surface	Under- ground	Surface	
Eastern Kentucky:					
Bell	17	46	1,265	3,052	NA
Boyd	--	7	--	267	NA
Breathitt	2	64	20	6,442	NA
Carter	--	34	--	332	NA
Clay	19	50	220	568	NA
Elliott	--	12	--	371	NA
Floyd	88	38	2,213	2,335	NA
Greenup	--	13	--	211	NA
Harlan	98	75	8,540	1,978	NA
Jackson	2	24	W	603	NA
Johnson	7	74	248	3,477	NA
Knott	77	50	2,788	1,583	NA
Knox	6	45	115	990	NA
Laurel	3	60	38	1,177	NA
Lawrence	--	29	--	1,163	NA
Lee	--	12	--	267	NA
Leslie	49	77	1,804	2,519	NA
Letcher	69	39	2,833	1,283	NA
McCreary	3	8	W	274	NA
Magoffin	5	42	71	2,177	NA
Martin	21	57	2,786	5,423	NA
Menifee	--	1	--	3	NA
Morgan	--	34	--	604	NA
Owsley	1	14	W	211	NA
Perry	54	111	2,547	6,349	NA
Pike	305	116	14,220	4,782	NA
Pulaski	3	8	W	322	NA
Rockcastle	--	5	--	52	NA
Wayne	--	4	--	174	NA
Whitley	3	68	W	1,377	NA
Wolfe	--	10	--	214	NA
Undistributed	--	--	843	--	NA
Total	827	1,227	40,551	150,587	\$2,099,281
Western Kentucky:					
Butler	1	25	54	831	NA
Christian	--	4	--	220	NA
Daviess	--	6	--	1,005	NA
Grayson	--	1	--	1	NA
Hancock	--	4	--	131	NA
Henderson	2	--	1,084	--	NA
Hopkins	8	31	5,277	4,582	NA
McLean	--	4	--	751	NA
Muhlenberg	7	12	5,044	15,085	NA
Ohio	3	31	3,125	5,780	NA
Union	6	--	7,632	--	NA
Warren	--	2	--	15	NA
Webster	1	13	1,755	512	NA
Total	28	133	23,921	23,913	749,409

NA Not available by county. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

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

In western Kentucky, 161 mines produced 52.8 million tons of coal while the previous year, 182 mines located in 14 counties produced 56.4 million tons. The number of surface mines decreased from 155 in 1975 to 133 in 1976 and the production from these operations decreased from 31.4 million in 1975 to 28.9 million in 1976. The average number of men working daily at these operations decreased from 3,920 in 1975 to 3,742 in 1976. Underground coal production decreased from 25.0 million tons in 1975 to 23.9 million tons in 1976, and the number of operating mines increased one from the total of 27 operations in 1975. The average number of men working daily, however, decreased from 6,700 in 1975 to 6,270 in 1976.

Natural Gas.—Natural gas production showed a 9% improvement over that of

the previous year increasing from 60,511 million cubic feet to 66,137 million cubic feet having a value of \$36.4 million, or about 54.9 cents per thousand cubic feet. The number of producing wells increased from 7,386 in 1975 to 7,505 in 1976.

Petroleum.—Even though 327 new wells were drilled and an increasing number of organizations were conducting exploration studies during the year, petroleum production continued to decline, but at a more gradual rate compared with the 1974 and 1975 production. This indicates that an increasing share of the overall annual production was obtained from stripper wells. Production declined from 7.56 million barrels in 1975 to 7.48 million barrels in 1976. Since 1972, petroleum production has decreased nearly 23%.

Table 5.—Kentucky: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Adair	28	--	16	3	1	29	77	116,184
Allen	11	--	10	5	--	11	37	18,484
Barren	5	--	2	1	--	12	20	9,798
Bell	--	--	--	--	--	1	1	2,400
Boyd	--	4	--	--	--	--	4	18,026
Breathitt	--	2	1	--	1	2	6	12,667
Breckinridge	2	--	1	--	--	4	7	8,137
Butler	--	--	4	--	--	7	11	18,444
Calloway	--	--	--	--	--	1	1	1,085
Casey	--	--	--	--	--	1	1	1,812
Christian	4	2	6	--	1	3	16	15,489
Clay	--	15	2	--	5	7	29	45,286
Clinton	4	--	4	3	1	10	22	19,858
Crittenden	--	--	--	--	--	2	2	3,716
Cumberland	27	--	38	14	1	29	104	109,298
Daviess	19	7	29	1	1	7	64	86,714
Elliott	5	--	--	--	--	1	6	6,567
Estill	2	--	--	--	1	--	3	3,810
Grayson	1	26	--	--	--	2	29	32,291
Green	60	--	27	7	--	18	112	148,165
Greenup	--	--	--	--	--	1	1	3,817
Hancock	5	--	8	1	--	2	16	12,494
Hardin	--	--	3	--	--	--	3	2,942
Harlan	--	--	--	--	--	2	2	10,111
Hart	6	--	--	--	--	5	13	12,088
Henderson	16	--	6	--	--	1	23	49,925
Hopkins	5	3	14	1	--	11	34	78,685
Jackson	--	--	--	1	--	--	1	705
Knott	3	10	4	--	1	--	18	42,808
Knox	--	1	--	--	2	--	3	4,576
Larue	--	--	1	--	--	1	1	914
Laurel	--	--	1	--	--	--	1	1,036
Lawrence	5	1	1	--	3	1	11	15,291
Lee	9	--	--	1	--	1	11	14,030
Leahe	2	9	2	1	1	3	18	47,814
Letcher	3	6	1	1	2	--	13	45,205
Lincoln	--	--	1	--	--	2	3	699
Logan	--	--	--	--	--	2	2	2,981
McCreary	--	--	--	--	--	3	3	4,544
McLean	18	2	12	4	1	9	46	87,972
Madison	--	--	--	--	--	1	1	215
Magoffin	2	--	1	--	1	--	4	7,693
Marion	--	--	--	--	--	1	1	1,566
Martin	--	1	--	--	1	--	2	6,670
Metcalf	2	--	12	1	--	14	29	18,680
Monroe	3	--	--	1	--	11	15	6,151
Montgomery	--	--	--	--	--	1	1	960
Morgan	--	--	--	--	--	2	2	1,421
Muhlenberg	20	6	12	1	1	10	50	78,235
Nicholas	--	--	--	--	--	1	1	2,958
Ohio	22	--	17	1	2	10	52	39,333
Perry	2	10	--	1	3	1	17	54,163
Pike	1	8	1	--	2	1	13	36,860
Powell	8	--	--	--	--	1	9	7,864
Pulaski	--	--	--	--	--	1	1	2,010
Russell	--	--	--	--	--	4	4	6,190
Simpson	--	--	3	1	--	6	10	6,627
Spencer	--	--	--	--	--	1	1	1,515
Taylor	1	--	1	--	--	1	3	2,012
Todd	--	--	--	--	--	1	1	1,308
Trigg	--	--	--	--	1	1	2	5,612
Union	14	--	8	--	--	5	27	55,054
Warren	7	--	2	2	--	4	15	11,479
Wayne	--	--	4	--	--	5	9	5,543
Webster	5	--	7	2	2	7	23	61,760
Whitley	--	1	1	--	2	--	4	7,598
Wolfe	--	--	--	--	--	1	1	12,323
Total	327	114	259	54	37	282	1,073	1,537,508

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Table 6.—Kentucky: Crude oil production, by county
(Thousand 42-gallon barrels and thousand dollars)

County	1975	1976
Adair	188	151
Allen	29	29
Barren	7	8
Bell	1	(¹)
Boyd	2	2
Bracken	1	--
Breathitt	20	20
Breckenridge	7	5
Butler	37	37
Casey	4	2
Christian	107	91
Clay	6	5
Clinton	35	46
Crittenden	(¹)	--
Cumberland	50	60
Daviess	618	581
Edmonson	1	(¹)
Elliott	31	29
Eatill	101	90
Floyd	11	14
Grayson	--	(¹)
Green	40	149
Greenup	1	(¹)
Hancock	78	78
Hart	16	13
Henderson	929	874
Hopkins	427	377
Johnson	182	175
Knott	9	15
Knox	3	3
Knox	2	2
Laurel	128	130
Lawrence	1,041	934
Lee	4	12
Leslie	450	422
Letcher	(¹)	(¹)
Logan	(¹)	(¹)
McCreary	(¹)	(¹)
McLean	353	407
Magoffin	120	106
Martin	11	11
Metcalf	10	7
Monroe	9	12
Monroe	1	1
Morgan	335	356
Muhlenberg	195	193
Ohio	1	(¹)
Owsley	250	200
Perry	44	49
Pike	78	129
Powell	(¹)	2
Pulaski	(¹)	(¹)
Rowan	2	1
Russell	7	5
Simpson	(¹)	--
Taylor	1	15
Todd	1,055	1,045
Union	17	40
Warren	4	4
Wayne	424	482
Webster	10	9
Whitley	77	56
Wolfe		
Total ²	7,556	7,483
Value	84,520	85,454

¹ Less than 500 barrels.

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

NONMETALS

Cement.—The Kosmosdale cement plant, subsidiary of The Flintkote Co., located in Jefferson County, was the State's only cement plant. More than three-fourths of this production was used for ready-mix purposes; concrete products manufacturers, building material dealers, and highway contractors used the remaining one-fourth.

Clays.—Clay production declined nearly 3.1% during the year. Two companies mined ball clay from five operations while five companies produced fire clay from eight operations and seven other organizations produced a commercial clay and shale product. Ball and fire clays were processed and packaged or shipped in bulk to manufacturers of pottery ware, floor and wall tile, or for use as paper filler, refractory ware, and fire brick.

Fluorspar.—The Frontier Spar Corp. operated a mine and mill near Salem, and Kenspar Co. operated a mine and a small flotation plant in southern Crittenden County near Mexico.

Graphite.—One company produced a small amount of synthetic graphite in Fulton County for electrode use.

Lime.—The Black River Mining Co., Pendleton County, produced quicklime for steel furnaces and lime dust for coal mining purposes. The Dravo Lime Co., a subsidiary of the Dravo Corp., expanded its mining operations and installed lime kilns plus storage capacity at its Mason County operation. These especially prepared limes will be used primarily for SO₂ removal purposes by coal-burning thermal power-plants.

Perlite.—Two companies processed ores shipped from out-of-State to produce expanded perlite used primarily for roof insulation and agricultural needs.

Sand and Gravel.—Thirty-nine sand and gravel operations produced a total of 9.2 million tons having a value of \$15.3 million. The bulk of this production was used for concrete aggregate, and roadway, construction, and foundry purposes, with a small quantity being used for glassmaking.

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

Use	1975		1976		Average value per ton
	Quantity (thousand short tons)	Value ¹ (thousands)	Quantity (thousand short tons)	Value (thousands)	
Construction:					
Sand -----	6,861	\$9,457	7,117	\$11,092	\$1.56
Gravel -----	1,648	2,823	1,995	3,897	1.95
Total -----	² 8,902	² 12,609	³ 9,111	³ 14,989	1.64
Industrial sand -----	22	232	43	282	6.56
Grand total -----	8,924	12,841	9,154	15,271	1.67

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant of blended processed sand and gravel used in construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

² Includes data for unprocessed sand and gravel.

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

Table 8.—Kentucky: Construction sand and gravel sold or used, by major use category

Use	1976		Average value per ton
	Quantity (thousand short tons)	Value (thousands)	
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) --	4,232	\$6,696	\$1.58
Concrete products (cement blocks, bricks, pipe, etc.) --	1,366	1,980	1.45
Asphaltic concrete aggregates and other bituminous mixtures -----	2,736	5,185	1.90
Roadbase and coverings -----	221	320	1.45
Fill -----	474	658	1.39
Other uses -----	82	150	1.83
Total -----	9,111	14,989	1.64

Stone.—Operations at 118 quarries and underground mines produced 33.4 million tons of stone valued at \$77.1 million. Although the bulk of limestone production

was used for highway, waterway, and railroad construction purposes, a considerable tonnage was used as agricultural limes and for residential construction purposes.

Table 9.—Kentucky: Crushed stone¹ sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	9,751	20,585	9,228	21,410
Roadstone -----	5,596	11,499	5,080	11,610
Riprap and jetty stone -----	2,313	5,126	4,541	11,010
Concrete aggregate -----	3,934	8,469	3,662	8,346
Bituminous aggregate -----	3,498	7,494	2,871	6,450
Agricultural limestone -----	2,059	4,706	2,452	5,708
Surface treatment aggregate -----	1,814	2,735	1,480	3,168
Macadam aggregate -----	517	1,067	1,008	2,077
Cement manufacture -----	940	1,624	957	1,580
Lime manufacture ² -----	W	W	851	1,710
Railroad ballast -----	373	780	429	959
Ferrosilicon -----	W	W	38	190
Other uses ³ -----	1,439	3,821	784	2,845
Total ⁴ -----	31,734	67,906	33,378	77,060

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

¹ Includes limestone and sandstone.

² Includes stone used in chemical stone for alkali works.

³ Includes stone used for mine dusting, flux stone, filter stone, fill, drain fields, soil conditioning (1975), bedding materials (1975), other filler (1975), unspecified uses, and uses indicated by symbol W.

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

METALS

The value of metallic ores was less than 1% of the total value of mineral production.

The National-Southwire Aluminum Co. continued operations at Hawesville (Hancock County).

The Frontier Spar Corp. produced a

small quantity of zinc as a byproduct at the Barnes mine in Crittenden County. During 1976, a total of 118,695 pounds of zinc was recovered having a value of \$43,917.

Armco Steel Corp. produced small quantities of both pig iron and iron oxide pigments at its Ashland plant in Boyd County.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum (primary):			
Anaconda Aluminum Co ---	Box 1654 Louisville, Ky. 40201	Smelter -----	Henderson.
National-Southwire Aluminum Co.	Box M Hawesville, Ky. 42348	----do -----	Hancock.
Cement: The Flintkote Co. ¹ ---	Dixie Highway Kosmosdale, Ky. 40272	Plant -----	Jefferson.
Clays:			
Kentucky-Tennessee Clay Co.	Box 77 Mayfield, Ky. 42066	Mines and plants --	Graves.
Old Hickory Clay Co -----	Box 271 Paducah, Ky. 42351	Mines -----	Do.
Coal:			
Amax Coal Co -----	150 South Meridan St. Indianapolis, Ind. 46225	Strip mine -----	Muhlenberg.
Beth-Elkhorn Corp -----	701 East 3d St. Bethlehem, Pa. 18016	Underground mines.	Letcher and Pike.
Island Creek Co -----	Wheelwright, Ky. 41669	----do -----	Floyd, Hop- kins, Muh- lenberg, Pike, Union.
Peabody Coal Co -----	301 North Memorial Dr. St. Louis, Mo. 63102	Underground and strip mine.	Muhlenberg, Ohio, Union.
Pittsburg & Midway Coal Mining Co.	Tenmain Center Kansas City, Mo. 64105	Underground and strip mines.	Hopkins and Muhlenberg.
United States Steel Corp --	525 William Penn Pl. Pittsburgh, Pa. 15230	Underground and auger mines.	Harlan.
Coke:			
Allied Chemical Corp -----	40 Rector St. New York, N.Y. 10006	Plant -----	Boyd.
Ferrous alloys:			
Airco Alloys and Carbide --	Box 217 Calvert City, Ky. 42029	----do -----	Marshall.
Graphite (artificial):			
The Carborundum Co -----	Hickman, Ky. 42050	----do -----	Fulton.
Iron (pig):			
Armco Steel Corp -----	Middletown, Ohio 45202	----do -----	Boyd.
Interlake, Inc -----	9th & Lowell Sts. Newport, Ky. 41071	----do -----	Campbell.
Lime:			
Black River Mining Co ----	Route 1 Butler, Ky. 41006	----do -----	Pendleton.
Natural gas:			
Columbia Gas Transmission Inland Gas Co -----	Charleston, W. Va. 25325 -- 340 17th St.	Gas wells -----	Various. Do.
Kentucky-West Virginia Gas Co.	Ashland, Ky. 41101 Second National Bank Bldg. Ashland, Ky. 41101	----do -----	Do.
Texas Gas Transmission Co.	Owensboro, Ky. 42301	----do -----	Do.
Wiser Oil -----	Box 192 Sistersville, W. Va. 26175	----do -----	Do.
Perlite (expanded):			
W. R. Grace & Co. ² -----	62 Whittemore Ave. Cambridge, Mass. 02140	Plant -----	Campbell.
Grefco, Inc -----	Box 35 Florence, Ky. 41042	----do -----	Kenton.
Petroleum (crude):			
Ashland Oil and Refining Co. ³	1409 Winchester Ave. Ashland, Ky. 41101	Wells -----	Various.
Har-Ken Oil Co -----	Box 616 Owensboro, Ky. 42301	----do -----	Do.
Humble Oil & Refining Co.	2010 West Ohio St. Evansville, Ind. 47712	----do -----	Do.
Sun Oil Co -----	Box 5026, Lawnsdale Evansville, Ind. 47715	----do -----	Do.
Sand and gravel:			
Evansville Materials, Inc --	624 NW. Riverside Dr. Evansville, Ind. 47708	Dredge -----	Henderson.
Ingram Materials, Inc ----	Box 1049 Nashville, Tenn. 37202	----do -----	Livingston.
Martin Marietta Corp. ⁴ ----	Box 120 Mercersburg, Pa. 17236	----do -----	Boone, Jefferson, Oldham.
Nugent Sand Co -----	Box 6072 Louisville, Ky. 40206	----do -----	Jefferson.
E. T. Slider, Inc -----	Box 6041 Louisville, Ky. 40206	Pit -----	Do.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Kentucky Stone Co -----	400 Sherburn Lane Louisville, Ky. 40207	Underground mines, quarries and plants.	Various.
Reed Crushed Stone Co ----	Box 35 Gilbertsville, Ky. 42044	Quarry and plant -	Livingston.
Three Rivers Rock Co ----	Box 213 Smithland, Ky. 42081	----do -----	Do.

¹ Also clays.² Also exfoliated vermiculite.³ Also a refinery in Boyd County.⁴ Also stone.

The Mineral Industry of Louisiana

By Owen W. Jones¹ and Leo W. Hough²

In 1976 Louisiana maintained its second-place ranking in domestic mineral production value for the 19th consecutive year. The mineral fuels (crude petroleum, natural gas, and natural gas liquids) provided 96% of the record \$8.65 billion total value. Louisiana's mineral production plays a major role in the State's economy and an important role in the national economy. Louisiana is the Nation's largest producer of salt and a major producer of crude petroleum, natural gas, natural gas liquids, and sulfur. These commodities are important to industry and agriculture in the United States and worldwide. In addition, important quantities of alumina, metallic aluminum, nickel, cobalt, and copper were refined from imported ores.

Although the State's mineral production value totals to a very impressive figure, the economic impact is much greater. The in-

dustry of the State is largely dependent on mineral fuels, either for fuel or for raw material. In the year 1974-76, capital investment in the mineral-related industries totaled approximately \$3 billion, according to the Louisiana Department of Commerce and Industry. At the end of 1976, mining employment was about 63,000, according to the Louisiana Department of Employment Security. In 1972, when the mineral production value was only \$5.4 billion, the U.S. Department of Commerce listed value added by manufacturing in the four mineral-industry-related Standard Industrial Classification categories as \$2.1 billion. Since that time, the value of the State's mineral production has increased 60%.

¹ State Liaison Officer, Bureau of Mines, Baton Rouge, La.

² State geologist, Louisiana Geological Survey, Baton Rouge, La.

Table 1.—Mineral production in Louisiana¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons--	531	\$1,132	513	\$1,158
Lime -----do-----	485	12,484	W	W
Natural gas -----million cubic feet--	7,090,645	2,999,179	7,006,596	3,223,034
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels--	31,808	178,930	27,078	151,683
LP gases -----do-----	103,714	392,039	91,701	375,057
Petroleum (crude) -----do-----	650,840	4,611,879	606,501	4,556,761
Salt -----thousand short tons--	12,166	77,116	13,491	91,952
Sand and gravel -----do-----	14,587	35,990	22,528	51,293
Stone -----do-----	10,489	38,260	9,685	28,127
Sulfur (Frasch) -----thousand long tons--	2,672	W	2,445	W
Value of items that cannot be disclosed:				
Cement, gypsum, and values indicated by symbol W -----	XX	166,266	XX	173,042
Total -----	XX	8,513,275	XX	8,652,107
Total 1967 constant dollars -----	XX	3,368,703	XX	P 3,110,432

^P Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

Table 2.—Value of mineral production in Louisiana, by parish¹
(Thousands)

Parish	1975	1976	Minerals produced in 1976 in order of value
Acadia	\$163,452	W	Natural gas liquids.
Allen	8,976	W	Sand and gravel, natural gas liquids.
Ascension	82,116	W	Natural gas liquids, salt.
Assumption	51,909	W	Salt.
Avozelles	5,333	--	
Beauregard	11,660	W	Sand and gravel, natural gas liquids.
Bienville	22,155	W	Clays.
Bossier	36,765	W	Natural gas liquids.
Caddo	36,122	W	Natural gas liquids, clays.
Calcasieu	84,876	\$19,122	Natural gas liquids, salt, stone.
Caldwell	W	--	
Cameron	671,737	W	Natural gas liquids, salt.
Catahoula	W	750	Sand and gravel.
Claiborne	35,153	W	Natural gas liquids.
Concordia	22,978	--	
De Soto	17,281	--	
East Baton Rouge	12,369	W	Sand and gravel, clays.
East Carroll	W	261	Sand and gravel.
East Feliciana	618	1,350	Do.
Evangeline	20,180	W	Natural gas liquids.
Franklin	2,318	--	
Grant	6,534	2,177	Sand and gravel.
Iberia	469,761	W	Salt, natural gas liquids.
Iberville	70,084	W	Do.
Jackson	1,587	--	
Jefferson	547,223	W	Sulfur, natural gas liquids, salt.
Jefferson Davis	67,196	W	Natural gas liquids, sand and gravel.
Lafayette	24,830	W	Do.
Lafourche	583,386	W	Sulfur, natural gas liquids.
La Salle	33,821	W	Sand and gravel.
Lincoln	15,348	W	Natural gas liquids, clays.
Livingston	W	W	Sand and gravel.
Madison	W	W	Do.
Morehouse	W	W	Do.
Natchitoches	61,326	W	Natural gas liquids, clays, sand and gravel.
Orleans	38,333	W	Cement, stone, lime.
Ouachita	W	W	Sand and gravel, natural gas liquids.
Plaquemines	1,697,159	W	Sulfur, natural gas liquids, salt.
Pointe Coupee	33,210	W	Natural gas liquids, clays.
Rapides	W	4,836	Sand and gravel.
Red River	380	W	Do.
Richland	45,968	W	Natural gas liquids.
Sabine	W	1	Sand and gravel.
St. Bernard	91,576	40,326	Natural gas liquids, clays, sand and gravel.
St. Charles	127,781	W	Natural gas liquids.
St. Helena	W	W	Sand and gravel, clays.
St. James	24,418	W	Natural gas liquids.
St. John the Baptist	W	--	
St. Landry	50,806	10,727	Do.
St. Martin	97,852	W	Salt, natural gas liquids, sand and gravel, clays.
St. Mary	1,016,590	89,163	Natural gas liquids, salt, stone, lime.
St. Tammany	W	W	Sand and gravel, stone, clays.
Tangipahoa	W	2,980	Sand and gravel.
Tensas	4,890	W	Natural gas liquids.
Terrebonne	1,265,588	W	Natural gas liquids, sulfur.
Union	3,051	W	Sand and gravel.
Vermilion	569,723	W	Natural gas liquids, sand and gravel.
Vernon	W	615	Sand and gravel.
Washington	2,938	4,348	Do.
Webster	43,535	W	Natural gas liquids, sand and gravel.
West Baton Rouge	8,117	--	
West Feliciana	W	3,337	Sand and gravel.
Winn	5,103	W	Stone, gypsum, sand and gravel.
Undistributed ²	219,164	8,472,114	
Total	³ 8,513,275	8,652,107	

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

¹No production was reported for West Carroll Parish.

²Includes petroleum, natural gas that cannot be assigned to specific parishes, and values indicated by symbol W.

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

Table 3.—Indicators of Louisiana business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,442.0	1,485.0	+3.0
Unemployment ----- do-----	106.0	101.0	-4.7
Employment (nonagricultural):			
Mining ----- do-----	59.1	62.4	+5.6
Manufacturing ----- do-----	186.2	191.6	+2.9
Contract construction ----- do-----	96.1	109.8	+14.3
Transportation and public utilities ----- do-----	99.0	100.5	+1.5
Wholesale and retail trade ----- do-----	286.1	298.9	+4.5
Finance, insurance, real estate ----- do-----	60.4	61.2	+1.3
Services ----- do-----	213.9	221.0	+3.3
Government ----- do-----	248.7	252.7	+1.6
Total nonagricultural employment ----- do-----	1,249.5	1,298.1	+3.9
Personal income:			
Total ----- millions--	\$18,428	\$20,762	+12.7
Per capita ----- do-----	\$4,842	\$5,405	+11.6
Construction activity:			
Number of private and public residential units authorized--	11,699	17,148	+46.6
Value of nonresidential construction ----- millions--	\$266.1	\$294.1	+10.5
Value of State road contract awards ----- do-----	\$253.5	\$280.9	+10.8
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	2,250	2,565	+14.0
Mineral production value:			
Total crude mineral value ----- millions--	\$8,513.3	\$8,652.1	+1.6
Value per capita, resident population ----- do-----	\$2,237	\$2,253	+0.7
Value per square mile ----- do-----	\$175,448	\$178,309	+1.6

^P Preliminary.

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

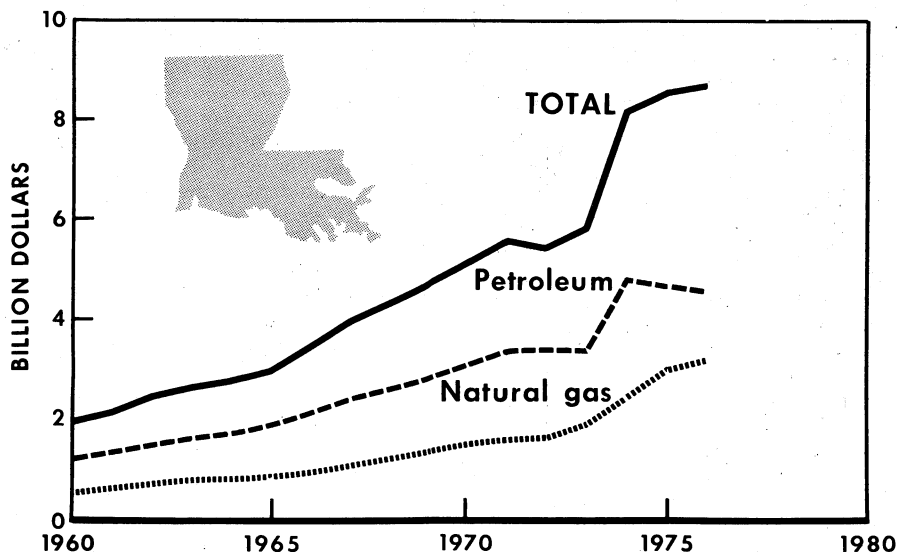


Figure 1.—Value of petroleum, natural gas, and total value of mineral production in Louisiana.

Trends and Developments.—Although Louisiana's mineral production continued to increase in value largely due to higher unit prices, the volume of production decreased. In 1976, each mineral commodity except salt, cement, and sand and gravel was produced in smaller volume than in 1975. The petroleum and natural gas production decline seems destined to continue indefinitely and will almost certainly necessitate establishment of a new State tax base in the near future.

Severance taxes and related mineral taxes (fuel taxes) and revenues (royalties, rents, and bonuses) furnish more than one-half of total revenue collections. Because of declining production, severance tax collections showed a decrease as early as 1971-72. Since that time, as oil and gas production has declined, the legislature has passed three severance tax increases, raising the natural gas severance tax from 2.3 cents to 3.3 cents per thousand cubic feet in 1972, and from 3.3 cents to 7 cents in 1973, and shifting the severance tax on oil from an average 23 cents per barrel to 12.5% of value, also in 1973. Although these increased tax rates, along with rising oil prices, kept the severance tax collections rising and more than made up for declining production they were necessarily a temporary solution to the problem, and in fiscal year 1975-76 collections declined.

The Louisiana Department of Commerce and Industry approved ad valorem tax exemption applications for \$1.11 billion of planned construction. This was the sixth straight year construction exemption applications exceeded \$1 billion. Investments in new plants totaled \$330.6 million, and plant expansions totalled \$777.8 million. Investment by industrial category showed petrochemicals and petroleum refining with \$798.3 million; metals and machinery, \$81.7 million; stone, clay, and glass, \$6.1 million; and power generation, \$41.3 million, for a total of \$927.4 million, or 84% of the total investment. While industrial investment was high, manufacturing employment continued to fall below the levels of most of the other States in the 11-State southern region, particularly in nonagricultural employment. In 1975, Louisiana ranked 38th in the Nation in manufacturing employment.

For several years the Outer Continental Shelf (OCS) has been an area of promise,

but lackadaisical bidding at recent Federal lease sales in the offshore Louisiana area seems to indicate that the highly desirable tracts have already been sold. Louisiana's mineral fuel production problems are of national significance because the State furnishes approximately one-fifth of the total domestic crude oil production and more than one-third of the domestic natural gas production.

The near-surface Louisiana salt domes offer not only a source of salt, but also very valuable storage space. Several are presently being used for Liquefied Petroleum Gases (LPG) storage and will be used for storage in conjunction with the proposed Louisiana Offshore Oil Port Inc. (LOOP), the deepwater port. In addition, they seem to offer the best and most economical storage space for the proposed Federal strategic crude-oil-storage program.

The Louisiana State Planning Office spent a year developing proposed legislation for a Coastal Zone Management program. The program goal was to set guidelines and regulatory procedures to protect marshlands and coastal fishery areas from detrimental effects of industrial operations and residential construction. The legislative plan was dropped in deference to opposition from coastal parishes to the large area proposed for land use planning and regulations that have never existed in Louisiana. Governor Edwards expressed a desire for a coastal zone bill to satisfy Federal requirements and no more. He authorized the House Natural Resources Committee to work with various groups interested in the measure to come up with such a bill.

LOOP received Environmental Protection Agency (EPA) approval to begin construction of a deepwater port, and EPA officially notified the U.S. Department of Transportation Secretary William Coleman that LOOP's plan would not violate air or water standards. Coleman was expected to issue a construction license for the facility which will cost \$425 million in its initial phase and could be pumping oil to the St. James capline (a pipeline carrying oil north from the Gulf States) by mid-1979. A feasibility study for the deepwater offshore oil port predicts a major expansion of refining and petrochemical processing plants in southeast Louisiana, primarily along the Mississippi River from Baton Rouge south, because of

the crude oil that will be imported through the port.

Dresser Industries, Inc., planned to spend approximately \$46 million for a new plant at Eunice. The primary product was to be rock bits and drilling tools for the petroleum industry. Dresser will also manufacture mining drill bits, blast-hole stabilizers, and raise-boring equipment. Completion was set for mid-1977.

An 80-acre tract between Baldwin and Franklin in St. Mary Parish was selected for a new \$50 million, 115-megawatt powerplant to be constructed by the Louisiana Municipal Power Commission (LAMPCO). The municipalities of Franklin, Morgan City, Opelousas, and Natchitoches were seeking to construct the central powerplant in order to generate 60% of their electricity requirements when the operation goes into production in late 1979 or early 1980. Thibodaux, an original member, has withdrawn. If constructed, it will be the first plant in the Nation to use the Texaco synthesis gas combined-cycle process, which burns and recycles low-cost, high-sulfur fuels.

At yearend, construction of a coal-fired electricity-generating plant continued at New Roads. Big Cajun No. 2 was being built by Cajun Electric Power Cooperative, Inc., a group of 12 rural electric cooperatives around the State. The projected need for electric power in the 1980's is so great that the group has begun a preliminary study for Big Cajun No. 3. The proposed new plant would either burn coal and be located adjacent to No. 2, or would burn Louisiana lignite at the mine site in northwest Louisiana.

Gulf States Utilities Co.'s proposed nuclear powerplant, just across the river from Big Cajun No. 2, was still embroiled in controversy. Delays due to regulations, obtaining permits, and environmental suits had more than doubled the projected cost of construction.

Statistics for the State's three major deep-water ports as reported by the U.S. Army Corps of Engineers for calendar year 1975, indicated that more than 200 million tons of waterborne commerce was handled. New Orleans, the Nation's second largest port, handled 140.0 million tons—mainly grain and crude petroleum. The Port of Baton Rouge handled 60.2 million tons; the largest single commodity was crude petroleum,

followed by gasoline. The Port of Lake Charles handled 17.4 million tons; crude petroleum was the largest single commodity.

Legislation and Government Programs.—The State legislature enacted several bills of interest to the mineral industry.

Act. No. 122 authorized the Commissioner of Conservation to make rules, regulations, and orders to regulate the disposal of waste products into the subsurface and granted the Department of Conservation jurisdiction over enforcement and bond requirements.

Act. No. 134 was enacted to promote the rapid and orderly development of geothermal resources within the State. Full regulatory authority over all geothermal exploration drilling, development, production, and conservation, as well as subsurface disposal of geothermal waters and/or waste, is vested in the State Department of Conservation. Disposal into any surface waters shall be under the supervision of the State Stream Control Commission.

Act. No. 141 provided for the control and regulation of surface mining of lignite deposits and other forms of coal to provide for the reclamation of lands and the protection of water supplies and the environment; it also gave authority to the Department of Conservation to implement the provisions of the act, and enumerated certain prerequisites for a permit for operations. Act. No. 141 is cited as the Louisiana Surface Mining and Reclamation Act.

Act. No. 641 related to underground storage of liquid and/or gaseous hydrocarbons. It provided that the Commissioner of Conservation shall have the power and duty to prescribe rules and regulations concerning the use and/or development of salt dome cavities for storage, and to determine the suitability and feasibility of their use.

Environment.—A new \$9.5 million wet gas scrubber was put into operation at the Baton Rouge refinery of Exxon Co., U.S.A. The facility is designed to collect and dispose of catalyst particles and substances that otherwise would go up the refinery's cracking unit stacks and into the air; the scrubber removes unwanted sulfur and ammonia compounds in addition to collecting fine particles of catalyst dust.

The Nation's first large-scale system for recycling refuse was opened at New Orleans in July. Owners predicted that 1,200 tons of iron and steel, 94 tons of aluminum, 1,200

tons of glass, and 520 tons of paper would be recovered per month.

The EPA gave a \$40,000 grant to Louisiana for hazardous wastes planning. The Governor's Council on Environmental Quality (CEQ) conducted a hazardous wastes survey in Louisiana. Bentley Mackay, Executive Director of the Council, said that in view of the act's intent and the nature of Louisiana's industrial development, unique geography, and hydrology, Louisiana will be among the dozen or so States most impacted by the hazardous waste management provisions. He believes the State and not the Federal Government should control waste disposal in Louisiana.

Concern was expressed by Louisiana and legislators about the prospect of storing nuclear wastes in underground salt domes in Louisiana. The Energy Research and Development Administration was scheduled to conduct field feasibility tests for nuclear waste storage. Some of the domes have been used for storing natural gas, petrochemicals, and LPG. Representative Henson Moore said that putting nuclear wastes in the domes would endanger the health of persons living near the domes and along the routes on which the radioactive material would be transported.

Energy.—The Louisiana Department of Conservation asked more than 1,700 industries to participate in an energy conservation program. The firms were issued a revised Energy Conservation Program Guide for Industry outlining conservation plans. The State agency will monitor individual plans. All industries using energy at rates greater than 1 billion Btu per year are required to submit semiannual reports.

Abnormally high pressure-versus-depth gradients exist in many of the Louisiana-

Texas gulf coastal areas. The deep surface waters in these areas are also very hot and contain dissolved methane gas. High-pressure hot waters from these areas are potentially large sources of energy, and the dissolved natural gas is an important additional source. These areas are being investigated as potential sources to meet Louisiana's future energy needs. Other energy sources being considered as replacements or supplements to the State's waning crude oil and natural gas supplies are—

1. Conversion of organic wastes such as animal manure, sewage, urban refuse, and industrial wastes. Organic materials can be converted directly to thermal energy by combustion or can be converted into more concentrated and cleaner fuels by chemical and biological processes.

2. A return to wood as a fuel. Wood is a renewable resource and the residual waste portions—bark, sawdust, edges, branches, tops, leaves, and stumps—are available for fuel use after primary uses such as lumber and papermaking have been satisfied.

3. Wind energy.

4. Solar energy. A steering committee to promote solar energy use in Louisiana is in operation on the Louisiana State University campus.

5. Water energy. Although Louisiana has water in abundance, the flat terrain precludes considerable dependence on hydroelectric generation. The only hydroelectric operation in the State is at the south end of Toledo Bend Reservoir on the Texas border. It produces 80 megawatts of power. Energy from the thermal difference in a deep submarine canyon about 50 miles south of Grand Isle in the Gulf of Mexico presents the possibility of a large future energy source.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Louisiana continued to be a leading domestic producer of crude petroleum and natural gas and a major supplier of natural gas liquids and refined petroleum products. The combined production value of the mineral fuels (crude petroleum and condensate, natural gas, and natural gas liquids) totaled \$8.3 billion in 1976. This was a slight increase in value over that of

1975. Fuels represented 96% of the total mineral production value in Louisiana, with nonmetallics making up the remaining 4%. At yearend, the State had 31,042 productive wells (30,560 in 1975) as follows: North Louisiana, 12,564 oil and 6,171 natural gas wells; south Louisiana onshore, 7,595 oil and 3,305 natural gas wells; and offshore, 1,065 oil and 342 natural gas wells in zone 1. In addition, the U.S. Geological Survey reported 3,153 producible oil com-

pletions and 2,088 producible gas completions in the Federal OCS area of Louisiana.

Leasing Activity.³—In north Louisiana, leasing activity increased, particularly during the last half of the year. Bonus prices increased, ranging from \$15 per acre to \$150 per acre, with \$25 to \$35 common for wildcat acreage. In south Louisiana, onshore leasing activity was up 64% on an acreage basis. Leasing continued to be active in the Cretaceous-Wilcox overlapping trends of south-central Louisiana, where cumulative leased acreage is estimated to exceed 1.8 million acres.

Offshore, the OCS tracts offered for sale continued to decrease. Only 84 tracts were offered off Louisiana, compared with 356 in 1975 and 761 in 1974. Twenty-four OCS leases expired or were surrendered to the Government in 1976. Exploratory holes had been drilled on all but three.

The OCS area within the 600-foot-depth line is nearly all under lease. Through the end of 1976, 8,528,990 acres of OCS lands off Louisiana had been leased. Excessive costs and technologic difficulties have convinced some operators to concentrate efforts in water less than 600 feet deep. High costs make any discovery with less than 50 million barrels of reserves uneconomic in waters over 800 feet deep.

Geophysical Activity.—In north Louisiana, geophysical activity decreased from 270 crew-weeks in 1975 to 220 crew-weeks. The most active parishes were Union, Natchitoches, Claiborne, and Sabine.

In south Louisiana onshore, geophysical activity increased 54% to 887 crew-weeks. The most active parishes were Livingston, St. Bernard, Vermilion, St. Landry, Allen, and Plaquemines. The active areas include portions of the deep, natural-gas-productive Cretaceous trend.

Geophysical work in the offshore area declined. Areas of major activity were West

Cameron, Ship Shoal, Eugene Island, East Cameron, and South Timbalier.

Exploration and Development Drilling.—The American Petroleum Institute (API) is the source of the drilling statistics published in the Minerals Yearbook. These statistics include data both from the area under State jurisdiction and from the OCS area under Federal control.

In north Louisiana, 1,517 development wells had a success ratio of 81%. Development drilling again was concentrated in the Monroe gasfield and in the Caddo-Pine Island field. Further development activity was evidenced in the Paluxy and Upper Cretaceous in De Soto Parish and in the Wilcox trend. There were 199 exploratory wells drilled with a success ratio of 16%. Significant discoveries were a deeper pay test in Grogan field, Natchitoches Parish, which found Smackover gas production more than 50 miles south of the "State line" Smackover trend; and a nearby gas producer also drilled to a deeper pay (the Cotton Valley) in Grogan field.

In south Louisiana, 735 development wells were drilled onshore for a success ratio of 60%. Offshore, 562 development wells were drilled for a success ratio of 77%. Exploratory wells onshore totaled 311 with a success ratio of 21%. Exploratory wells offshore totaled 101 with a success ratio of 4%. Exploration of the deep Cretaceous Tuscaloosa gas area actively continued during 1976. The trend apparently extends from Beauregard Parish on the western border of Louisiana to St. Bernard Parish on the eastern border. The presence of hydrogen sulfide in the gas produced from Tuscaloosa sandstones will require additional costly investments in drilling and completion equipment and in production facilities.

³ Adapted from the American Association of Petroleum Geologists Bulletin, V. 61, No. 8, August 1977.

Table 4.—Louisiana: Oil and gas well drilling completions in 1976, by parish

Parish	Development wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
NORTH LOUISIANA								
Bienville	--	10	9	--	2	3	24	226,760
Bossier	92	17	13	1	1	3	127	329,415
Caddo	165	33	39	--	3	6	246	556,099
Caldwell	--	6	8	--	2	16	32	107,870
Catahoula	9	--	19	1	--	22	51	274,375
Clabornne	13	15	7	2	--	9	46	450,716
Concordia	14	--	45	2	1	44	106	668,073
De Soto	13	39	21	1	3	9	86	341,829
East Carroll	1	--	1	--	--	--	2	11,628
Franklin	--	--	--	--	--	3	3	17,805
Grant	3	--	--	--	1	2	5	9,321
Jackson	--	2	4	--	1	1	6	50,694
La Salle	31	2	47	2	--	8	90	303,053
Lincoln	--	10	3	--	--	--	13	132,493
Madison	--	--	--	--	--	3	3	20,320
Morehouse	1	183	4	--	--	5	193	471,936
Natchitoches	--	--	--	--	2	2	4	36,640
Ouachita	--	144	3	--	1	4	152	418,292
Red River	11	5	3	--	2	4	25	90,289
Richland	2	--	5	--	--	--	7	19,268
Sabine	18	3	18	--	1	1	41	127,675
Tensas	15	2	7	--	--	5	29	229,586
Union	2	308	14	--	--	5	329	810,764
Webster	4	6	4	1	--	4	19	146,772
West Carroll	--	--	--	--	--	1	1	2,509
Winn	50	4	12	--	2	8	76	133,031
Total	444	787	286	10	21	168	1,716	5,987,213
SOUTH LOUISIANA								
Acadia	14	11	23	2	2	7	59	544,995
Allen	--	3	2	--	--	6	11	126,134
Ascension	--	2	4	--	--	4	10	88,199
Assumption	--	--	9	--	3	2	14	199,433
Avoyelles	6	--	6	--	--	2	14	117,264
Beauregard	--	2	8	--	--	9	19	189,988
Calcasieu	19	6	15	1	1	10	52	397,934
Cameron	36	13	35	1	5	22	112	917,778
East Baton Rouge	3	--	1	1	--	1	6	62,478
Evangeline	1	6	4	--	1	4	16	195,574
Iberia	10	5	9	--	4	5	33	347,893
Iberville	16	3	12	1	--	10	42	374,867
Jefferson	7	7	11	1	1	3	30	296,061
Jefferson Davis	6	8	17	1	--	11	43	468,576
Lafayette	--	--	2	--	1	1	4	31,172
Lafourche	34	12	18	3	2	22	91	1,051,368
Livingston	--	--	1	--	--	--	2	18,754
Orleans	--	--	--	--	--	1	1	10,017
Plaquemines	35	7	25	--	3	6	76	652,700
Pointe Coupee	--	2	2	--	1	1	6	84,882
Rapides	1	2	2	--	--	--	6	33,073
St. Bernard	--	--	1	--	1	3	5	41,675
St. Charles	3	5	4	1	2	6	21	232,230
St. James	6	2	1	1	2	7	19	186,291
St. John the Baptist	--	--	2	--	1	5	8	88,446
St. Landry	11	15	15	--	2	8	51	435,606
St. Martin	19	6	11	1	4	14	55	582,506
St. Mary	14	12	18	1	2	12	59	651,612
St. Tammany	--	--	--	--	2	--	2	22,746
Tangipahoa	--	--	--	--	--	2	2	30,661
Terbonne	29	26	21	1	5	35	117	1,390,973
Vermilion	7	10	10	1	2	21	51	640,881
Vernon	--	--	--	--	--	3	3	43,114
West Baton Rouge	1	1	2	--	--	3	7	81,600
Total	278	166	291	17	47	247	1,046	10,637,481
Offshore wells	198	234	130	1	3	97	663	5,725,709
State totals	920	1,187	707	28	71	512	3,425	22,350,403

Source: American Petroleum Institute.

Carbon Black.—Production was 1,033 million pounds, a 16.3% increase over the 1975 level and equivalent to 34% of total U.S. production. The combined production of Texas and Louisiana accounted for 79% of total U.S. carbon black production.

Table 5.—Louisiana: Carbon black production and value
(Million pounds and million dollars)

Year	Quantity	Value
1972	1,078	78.8
1973	1,208	96.8
1974	1,193	131.8
1975	888	102.7
1976	1,033	142.0

In spite of a 4-month strike in the tire industry, U.S. shipments of carbon black to the rubber industry in 1976 increased 6.5% for a total of 2,720 million pounds. U.S. exports of carbon black reached 111 million pounds in 1976, an increase of 26%, according to the Bureau of the Census.

Lignite.—A long-known lignite deposit in northwest-Louisiana is emerging as an area of interest in the present energy shortage. The Louisiana lignite is an extension of the lignite deposit of east Texas, which is presently being exploited for electrical power generation. The potential transportation-cost savings make this low-Btu fuel competitive with Wyoming and Montana coals that are being considered as the fuel for powering some of the electricity-generating plants planned in the State.

The Louisiana Geological Survey published Mineral Resources Bulletin No. 2, "Lignite—Evaluation of Near Surface Deposits in Northwest Louisiana." This publication presents results of a field program of drilling and coring as many locations as possible in the most promising near-surface lignite deposits of the State. The lignite cores recovered were analyzed at the Pittsburgh Energy Research Center, through a cooperative agreement with the Louisiana Geological Survey.

The investigation was initiated to locate an additional source of energy to supplement the declining oil and gas resources of the State. The initial investigation covered approximately 52,000 acres in the Dolet Hills southeast of the town of Mansfield in

southeastern De Soto Parish. An area in Sabine Parish was selected as a secondary area. It is hoped to enlarge the area of investigation in the near future. The potential resource indicated in De Soto Parish was estimated as 546 million tons having the equivalent calorific value of 1.3 billion barrels of oil or 8.2 trillion cubic feet of natural gas. The main lignite bed was 5 to 7 feet thick and was overlain by an average overburden of approximately 75 feet.

Natural Gas.—Marketed production of natural gas in Louisiana decreased slightly, from 7.091 trillion cubic feet to 7.007 trillion cubic feet. Value increased from \$3.0 billion to \$3.2 billion. This represented an average well-head price change from 42.3 cents per thousand cubic feet (Mcf) to 46.0 cents per Mcf. Louisiana ranked second in the Nation with 35% of total U.S. natural gas production. Gas well completions during the last 5 years follows:

Year	North	South	Offshore	Total
1972	451	234	133	818
1973	269	284	231	784
1974	458	190	141	789
1975	413	220	182	815
1976	808	211	239	1,258

At the end of 1976, Louisiana had 11,370 producing gas and condensate wells.

According to the American Gas Association (AGA), natural gas discoveries, extensions, and revisions in 1976 added 3.2 trillion cubic feet to natural gas reserves. In the same period, AGA reports production of 7.0 trillion cubic feet reduced reserves to 57.5 trillion cubic feet, a decline of 3.8 trillion cubic feet. The natural gas reserve has decreased each year since 1968, when yearend reserves totaled 88.0 trillion cubic feet. Most of the Louisiana natural gas reserve is offshore in the OCS area. Proved reserves at yearend 1975 and 1976 are shown in table 6.

At the end of 1976, Louisiana had seven dry-gas storage reservoirs with a total capacity of 381.9 billion cubic feet. Stored gas at yearend totaled 251.4 billion cubic feet.

Gas delivered to Louisiana consumers totaled 1,406 billion cubic feet in 1976. This was a 19-billion-cubic-foot decline compared with 1975 deliveries. Louisiana consumers used only 20% of the State's marketed production.

Table 6.—Louisiana: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves, Dec. 31, 1975	Changes in proved reserves due to net revisions, extensions, and discoveries in 1976	Proved reserves, Dec. 31, 1976 (API production deducted)	Change from 1975 (percent)
Crude oil _thousand barrels_	3,827,187	158,576	3,470,628	-9.3
Natural gas liquids _do_	1,717,700	109,628	1,622,834	-5.5
Natural gas million cubic feet	61,309,423	3,167,433	57,501,756	-6.2

Source: American Gas Association, American Petroleum Institute, and the Canadian Petroleum Association. Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada as of December 31, 1976. V. 3, May 1977.

Table 7.—Louisiana: Natural gas data
(Million cubic feet)

Year	Withdrawals			Disposition			
	From gas wells	From oil wells	Total ¹	Marketed production	Value at wells (thousand dollars)	Repressuring	Vented and wasted ²
1972	6,924,204	1,235,559	8,159,763	7,972,678	1,626,426	123,418	63,667
1973	7,347,732	1,143,462	8,491,194	8,242,423	1,846,303	146,680	102,091
1974	7,037,239	882,571	7,919,810	7,753,631	2,380,365	134,607	31,572
1975	6,455,690	786,718	7,242,408	7,090,645	2,999,179	126,304	25,459
1976	6,365,774	777,266	7,143,040	7,006,596	3,223,034	104,977	31,467

¹ Marketed production plus quantities used in repressuring, vented, and wasted.

² Partly estimated. Includes direct losses on producing properties and residue blown to the air.

Table 8.—Louisiana: Marketed production, interstate shipments, and total consumption of natural gas in selected producing States in 1976
(Billion cubic feet)

State	Marketed production	Receipts	Deliveries	Net receipts (+) or deliveries (-)	Change in underground storage	Adjustments ¹	Consumption
Louisiana	7,007	985	5,771	-4,786	36.9	-32.2	2,216
Oklahoma	1,727	1,246	2,161	-915	-3.8	2.6	812
Texas	7,192	635	3,397	-2,762	11.6	14.2	4,404
Total	15,926	2,866	11,329	-8,463	44.7	-15.4	7,432

¹ Includes transmission losses, changes in aboveground storage, and gas unaccounted for.

Three firms—Panhandle Eastern Pipeline Co., General Dynamics Corp., and Moore-McCormack Bulk Transport, Inc.—signed a letter of intent to construct and operate two liquefied natural gas carriers to bring Algerian natural gas to the United States. According to a gas purchase agreement between Panhandle and Sonatrach (the national oil and gas company of Algeria), about 165 billion feet of gas will be supplied annually over a 20-year period to

Panhandle and its transmission subsidiary, Trunkline Gas Co. The fuel would be regasified and distributed by pipeline from a Lake Charles regasification plant. Total cost was estimated at \$190 million. Approval by the Federal Power Commission (FPC) was hoped for in 1977. Gas deliveries are scheduled to start in 1980. Principal markets will be in Missouri, Illinois, Indiana, Ohio, and Michigan.

Table 9.—Louisiana: Quantity and value of natural gas delivered to consumers and other intrastate consumption of natural gas

	Number of consumers (thousands)		Quantity (million cubic feet)		Value (thousand dollars)	
	1975	1976	1975	1976	1975	1976
Delivered to consumers:						
Residential -----	914	846	96,221	95,457	131,630	149,963
Commercial -----	66	63	27,427	27,870	27,811	34,581
Industrial ¹ -----	XX	XX	922,673	901,750	702,154	851,252
Electric utilities -----	XX	XX	356,130	365,693	191,954	302,859
Other consumers -----	XX	XX	23,235	15,697	12,640	13,280
Total -----	XX	XX	1,425,686	1,406,467	1,066,189	1,351,935
Extraction loss:						
Natural gas processing -----	XX	XX	189,541	172,584	127,561	156,016
Lease and plant fuel -----	XX	XX	301,816	556,772	98,694	298,430
Pipeline fuel -----	XX	XX	61,086	80,466	23,701	39,998
Total natural gas consumption -----	XX	XX	1,978,129	2,216,289	1,316,145	1,846,379
Marketed natural gas production (includes consumption by producers) -----	XX	XX	7,090,645	7,006,596	2,999,179	3,223,034
Intrastate use as percent of production and value -----	XX	XX	27.9	31.6	43.9	57.3

XX Not applicable.

¹ Includes refinery fuel use and carbon black production.

Natural Gas Liquids.—Louisiana continued to rank second after Texas in natural gas liquids production. In 1976 production was 118.8 million barrels, down from 135.5 million barrels in 1975. Average value of natural gas liquids (including ethane) was \$4.43 per barrel.

According to an Oil and Gas Journal survey,⁴ there were 108 natural gas processing plants in Louisiana at yearend 1976, with a total capacity of 23,576.8 million cubic feet per day (MMcfd). Natural gas throughput at these plants averaged 16,439.4 MMcfd, representing a plant capacity utilization of 70%.

The AGA estimated that natural gas liquids reserve at the end of 1976 totaled 1,623 billion barrels. This was 5.5% less than at the end of 1975, making 1976 the eighth consecutive year that reserves de-

clined. Louisiana accounted for 25% of the Nation's total natural gas liquids reserve.

Sales of LPG and ethane were down 9.5% in 1976 as follows:

Sector	Consumption (thousand barrels)		Change, percent
	1975	1976	
Residential and commercial -----	2,454	2,283	-7.0
Internal combustion engine fuel -----	757	871	+15.1
Industrial ¹ -----	2,665	1,871	-29.8
Miscellaneous uses ² -----	1,033	1,228	+18.9
Total -----	6,909	6,253	-9.5

¹ Includes refinery fuel.

² Includes secondary recovery of petroleum, agricultural uses, and use as synthetic natural gas feedstock.

⁴ Oil and Gas Journal. Survey of Gas Processing Plants. V. 75, No. 28, July 11, 1977, pp. 82-132.

Petroleum.—Louisiana continued to rank second after Texas in petroleum production, accounting for 20.4% of the U.S. total. Crude oil production rates declined for the fifth consecutive year, production of 606.5 million barrels in 1976 represented a 6.8% decline from 1975 production. According to API statistics, the crude oil reserve at yearend totaled 3.47 billion barrels, down 357 million barrels from that of 1975. Additions to reserves based on reevaluation of known reservoirs, extensions of known fields, and discoveries of new fields and reservoirs amounted to approximately 26% of the amount lost by production.

The National Stripper Well Association survey for the year ending January 1, 1976, credited Louisiana with 12,723 stripper wells, which produced 7.6 million barrels of oil, or only 1.2% of total production of crude oil. Productivity decline of stripper wells will not appreciably affect State's productive capacity.

According to a Federal Bureau of Mines survey, there were 24 refineries operating in Louisiana with a total operating capacity of 2,060,800 barrels per calendar day at yearend 1976, an increase of 306,700 barrels per day from 1975 capacity. Most of the increase was accounted for by the newly completed refinery at Garyville, St. John the Baptist Parish, where Marathon of Ohio purchased the ECOL, Ltd., refinery and a newly formed subsidiary bought all the capital stock of

Table 10.—Louisiana: Crude oil production, indicated demand, and stocks in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within State
January	52,966	51,702	28,883
February	48,715	49,780	27,988
March	52,671	53,207	26,973
April	49,305	48,466	29,159
May	52,008	55,790	28,042
June	50,749	53,194	28,349
July	52,017	53,299	27,603
August	51,294	52,762	26,251
September	49,857	49,554	28,807
October	48,920	48,005	30,550
November	48,152	51,434	27,390
December	49,847	50,481	26,404
Total:			
1976	606,501	617,674	XX
1975	650,840	658,086	XX

XX Not applicable.

Table 11.—Louisiana: Production of crude petroleum, by district and selected fields

(Thousand 42-gallon barrels)

District and field ¹	1975	1976
Gulf coast onshore:²		
Bay de Chene	4,870	4,022
Bay Ste. Elaine	3,867	3,500
Bayou Sale	2,618	2,152
Black Bay West	6,245	5,471
Caillou Island	14,035	12,479
Cote Blanche Island	3,643	1,795
Garden Island Bay	7,504	6,981
Golden Meadow	2,478	2,628
Grand Bay	3,067	2,277
Hackberry East	1,529	1,531
Hackberry West	2,203	1,790
Lafitte	5,524	5,050
Lake Barre	3,518	4,213
Lake Pelto	3,864	3,353
Lake Washington	5,493	4,464
Leeville	3,183	2,747
Paradis	4,749	3,871
Quarantine Bay	3,090	2,219
Romere Pass	1,764	1,794
Timbalier Bay onshore	6,115	5,466
Venice	3,788	3,087
Vinton	2,750	1,999
Weeks Island	5,035	3,792
West Bay	5,692	5,187
West Cote Blanche Bay	7,877	5,814
Other fields	143,044	135,643
Total	257,045	232,425
Gulf coast offshore:²		
Bay Marchand Block 2 (including onshore)	22,416	21,914
Eugene Island Block 126	3,690	3,032
Eugene Island Block 175	5,008	3,805
Eugene Island Block 276	4,365	3,363
Eugene Island Block 330	27,903	31,192
Grand Isle Block 16	11,377	8,200
Grand Isle Block 43	17,592	14,781
Grand Isle Block 47	2,996	2,889
Main Pass Block 35	1,620	1,608
Main Pass Block 41	9,058	6,743
Main Pass Block 69	5,565	5,042
Main Pass Block 306	4,794	4,887
Ship Shoal Block 204	4,359	4,483
Ship Shoal Block 207	5,075	6,191
Ship Shoal Block 208	3,361	7,378
South Marsh Island Block 73	3,633	3,069
South Pass Block 24 (including onshore)	12,868	10,746
South Pass Block 27	9,528	5,543
South Pass Block 61	3,619	9,918
South Pass Block 62	5,454	4,231
South Pass Block 65	8,471	7,114
Timbalier Bay Block 21	5,557	2,251
West Delta Block 30	17,731	16,768
West Delta Block 58	9,026	9,636
West Delta Block 73	8,268	8,035
Other fields	138,123	133,030
Total	356,457	335,849
Northern:		
Caddo-Pine Island	2,966	3,002
Delhi	6,658	6,542
Haynesville (Ark., La.)	1,674	1,528
Other fields	26,040	27,155
Total	37,338	38,227
Grand total	650,840	606,501

^r Revised.

¹ Breakdown for individual fields from the Oil and Gas Journal.

² Some fields include onshore and offshore production.

ECOL, Ltd., a subsidiary of Energy Corp. of Louisiana. The 200,000-barrel-per-day refinery was nearing completion when purchased. It was designed to handle high-sulfur "sour" crude of the type imported from the Arab nations. The installation was the largest refinery ever built in a single phase in the United States.

Tenneco Corp. announced plans for a 30,000-barrel-per-day expansion at its Chalmette refinery. An atmospheric crude distillation unit and a naphtha prefractionating tower are the major units involved. The expansion will boost plant capacity to more than 100,000 barrels per day. The new facility is scheduled to go onstream in late 1977.

New refinery capacity under construction at the end of 1976 totaled 78,500 barrels of crude throughput per calendar day. Operating gasoline output capacity totaled 864,868 barrels per calendar day, and 19,700 barrels per day was under construction at yearend.

Petrochemicals.—Cos Mar Inc.'s new \$55 million styrene monomer facility was dedicated in October. The plant has a production capacity of 700 million pounds per year which, together with an existing 600-million-pound facility, makes it the world's largest complex at a single location.

Air Products & Chemicals, Inc., completed the world's largest alkylamines plant at St. Gabriel. The new \$30 million plant will produce over 100 million pounds per year, mainly higher amiens for use in producing herbicides.

American Cyanamid Co. will locate a new \$20 million sulfuric acid facility at its Fortier complex. The plant, located near Waggaman in Jefferson Parish, will have a capacity of 530,000 tons of sulfuric acid per year. Total production capacity will exceed 1 million tons annually.

C. F. Industries began work on a \$200 million, four-part expansion of its Donaldsonville chemical complex. The first segment of the expansion program, a 1,150-ton-per-day ammonia plant, will more than double the size of the existing facility and should be completed in early 1977. Also scheduled for completion in April 1977 is another ammonia plant the same size as the original expansion.

NONMETALS

Value of nonmetals production was \$346 million, up \$14 million from the 1975 figure. Nonmetals value comprised 4% of the State's total mineral value. Although overshadowed by the monetary value of the mineral fuels, production of these minerals provides a sizable and essential source of raw material for the construction, agricultural, and chemical industries in the State, Nation, and overseas.

Barite.—Crude barite ore, mined domestically and abroad, was shipped to Louisiana to be processed. Three grinding plants operated in Orleans Parish, and one each in Assumption, Calcasieu, St. Martin, and Terrebonne Parishes. Virtually all the processed barite was used as a drilling mud weighting additive. Output of ground barite was 685,577 short tons, a 10% increase. Value was \$26.7 million, a 15% increase.

Cement.—Louisiana Cement Co., a division of OKC Corp., and Lone Star Industries, Inc., both in New Orleans, produced portland cement. Louisiana Cement also produced and sold masonry cement, and Lone Star sold masonry cement shipped in from another source. Portland cement accounted for 98% of the total production. Ready-mix companies and highway and other contractors used approximately 70% of total production. Raw materials used in making cement included shell, limestone, aragonite, clay, sand, gypsum, and iron ore. Both plants used natural gas as the primary fuel, along with small quantities of fuel oil.

Clays.—Output totaled 513,000 tons, compared with 531,000 tons in 1975. Average unit value increased from \$2.13 per ton to \$2.26 per ton, making a total production value of \$1.16 million. Eight brick companies at 10 mines, 1 lightweight aggregate company, and 1 cement manufacturing company reported clay and/or shale production. Principal producing parishes in descending order of production were Pointe Coupee, St. Bernard, St. Helena, East Baton Rouge, and Caddo.

Lightweight aggregate production consumed 37% of the total output, cement manufacture, 29%, and brick manufacture, 34%.

The Louisiana Geological Survey continued sampling Louisiana clays for testing and evaluation by the Federal Bureau of Mines at its Metallurgy Research Center in Tuscaloosa, Ala. The testing program is conducted under cooperative agreement between the State and the Federal Bureau of Mines.

Table 12.—Louisiana: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1972 -----	1,000	1,454
1973 -----	979	1,329
1974 -----	770	1,425
1975 -----	531	1,132
1976 -----	513	1,158

Gypsum.—Winn Rock, Inc., mined gypsum at Winnfield. The product was used as a retarder in portland cement. Output declined 8%. United States Gypsum Co. and National Gypsum Co. calcined gypsum in Orleans and Jefferson Parishes. Output was considerably greater than that in 1975.

Lime.—Pelican State Div. of S. I. Lime Co. in St. Mary Parish and United States Gypsum Co. in Orleans Parish produced lime. Production decreased markedly. Lime consumption in Louisiana was principally for use in chemical plants, aluminum smelters, and water purification facilities.

Perlite and Vermiculite.—Perlite produced outside Louisiana was expanded by Filter Media Co. of Louisiana, Inc., at

Reserve, St. John the Baptist Parish, and by American Perlite Products, Inc., at Gilliam, Caddo Parish. Production declined compared with 1975 output, but the price more than doubled. Principal uses were for filter aids, aggregate, and low-temperature insulation. In Orleans Parish, W. R. Grace & Co. produced exfoliated vermiculite, used principally as aggregate, block insulation, fireproofing, and horticulture.

Salt.—Salt sold or used totaled 13.5 million tons valued at \$92 million, or \$6.82 per ton. Louisiana ranked first in U.S. salt output and accounted for 31% of the U.S. total production. Fourteen companies produced salt at 17 active operations in 10 parishes. Of these, 11 operations produced only brine, 3 produced both evaporated and rock salt, 2 produced rock salt only, and 1 produced evaporated salt only. Evaporated salt averaged \$64.02 per ton; rock salt, \$7.13; and brine salt, \$3.96.

The Federal Energy Administration considered using four Louisiana salt domes to store emergency supplies of crude oil for the strategic petroleum reserve. Salt dome storage is an economic, proven, and safe method, not subject to lightning, fire, or deterioration. The gulf coast region is ideal because of its existing shallow salt domes, its access to the existing pipeline distribution system, and its many refineries. The domes chosen for the strategic storage program were Bayou Choctaw in Iberville Parish, West Hackberry in Cameron Parish, Weeks Island in Iberia Parish, and Cote Blanche in St. Mary Parish.

Table 13.—Louisiana: Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Evaporated salt		Rock salt		Brine		Total ¹	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1972 -----	269	8,840	6,142	34,032	7,104	24,592	13,514	67,464
1973 -----	285	9,976	5,411	30,065	7,456	26,170	13,152	66,211
1974 -----	296	11,386	6,024	38,641	7,223	26,932	13,543	76,960
1975 -----	275	15,112	5,320	36,542	6,572	25,462	12,166	77,116
1976 -----	297	19,014	6,514	46,465	6,680	26,473	13,491	91,952

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

Sand and Gravel.—Production was 22.5 million short tons, a 54% increase over that of 1975. Production value was up 43%. Average unit value was \$2.28 per short ton. A total of 96 companies with 144 operations reported production from 30 parishes. Leading parishes in descending rank of production were St. Tammany, West Feliciana, Washington, St. Helena, and East Baton Rouge. These five parishes produced 50% of the State's total output.

Louisiana deposits typically have about a 5:1 ratio of sand to gravel; the streams contain large quantities of sand, so sand supplies are plentiful. Some gravel producing areas, however, are becoming depleted. This fact, along with growing environmental constraints and competing higher land use values, has pointed to the possibility of a shortage of gravel for future major construction projects.

The Acadian Sand Co. near Abbeville expanded its operations to include lime-

stone aggregate barged to the site from Tennessee. The company invested nearly \$500,000 to modernize the sand operation. Limestone aggregates are a substitute for shell and gravel, which are in short supply. Some uses include aggregate for roadways, concrete, asphalt, and riprap, plus agricultural lime applications.

Table 14.—Louisiana: Sand and gravel sold or used by producers in 1976

Use	Quantity (thousand short tons)	Value (thou- sands)	Value per ton
Construction:			
Sand -----	10,580	17,680	\$1.67
Gravel -----	11,581	31,430	2.71
Total ----	22,161	¹ 49,109	2.22
Industrial sand--	367	2,184	5.95
Grand total --	22,528	51,293	2.28

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

Table 15.—Louisiana: Construction sand and gravel sold or used in 1976, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	9,081	22,477	\$2.43
Concrete products (cement blocks, bricks, pipe, etc.) ---	2,981	7,598	2.55
Asphaltic concrete aggregate and other bituminous mixtures -----	3,147	8,099	2.57
Roadbase and coverings -----	3,110	6,141	1.97
Fill -----	3,622	4,531	1.25
Other uses -----	219	264	1.21
Total ¹ -----	22,161	49,109	2.22

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

Stone.—Production was principally oyster and clam shell dredged from shell beds in gulf coast area lakes and bays. Among the States, Louisiana led in output of shell. Winn Rock, Inc., Winn Parish, quarried stone from the caprock overlying the Winnfield intrusive salt dome. Stone and shell are used for roadstone, roadbase stone, bituminous aggregate, and other uses. Output decreased 8% to 9.7 million tons valued at \$28.1 million. Leading producers were Southern Industries, Inc., Lake Charles Dredging & Towing Co., and Louisiana Materials Co.

Sulfur.—Frasch sulfur was produced only in Texas and Louisiana. Louisiana production was 2,487,000 long tons, or 40% of the U.S. total. Louisiana mines shipped 2,445,000 long tons, or 42% of total U.S. shipments. The value of Louisiana shipments was withheld to avoid disclosing company proprietary data; total U.S. shipments were valued at \$300 million.

Frasch sulfur accounted for 59% of the U.S. domestic sulfur production in all forms. In Louisiana, it was produced at three Freeport Minerals Co. mines and one Texasgulf, Inc., mine.

Louisiana shipped 122,000 long tons of recovered sulfur, up from 91,000 long tons in 1975. The State ranked seventh in the Nation in this category.

Table 16.—Louisiana: Sulfur produced and shipped from Frasch mines
(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1972 -----	3,534	3,765	W
1973 -----	3,311	3,329	W
1974 -----	3,308	3,426	W
1975 -----	3,070	2,672	W
1976 -----	2,487	2,445	W

W Withheld to avoid disclosing company proprietary data.

METALS

Aluminum.—Kaiser Aluminum & Chemical Corp. produced alumina at its Gramercy and North Baton Rouge plants. The bauxite, imported from Jamaica, was processed and shipped downriver to the Kaiser reduction plant at Chalmette.

Ormet Corp. produced alumina at its Burnside plant. Bauxite was imported from Surinam. The alumina was shipped upriver to Ormet's reduction plant in Ohio.

Consolidated Aluminum Corp. (Conalco) at Lake Charles received alumina from out-of-State sources and reduced it to metallic aluminum. The Conalco plant also produced calcined coke for electrodes used in aluminum production.

Louisiana ranked eighth among the 16 States reporting aluminum production.

Nickel.—AMAX Nickel Refining Co., Inc., began producing nickel late in 1974 at its rehabilitated nickel-copper refinery at Port Nickel, 15 miles south of New Orleans. Since that time, considerable quantities of nickel-copper-cobalt matte have been imported from Botswana and the Republic of South Africa, along with nickel-cobalt matte from New Caledonia. Rated capacity of the plant is 40,000 tons of nickel, 23,500 tons of copper, 500 tons of cobalt, and 100,000 tons of ammonium sulfate. Designed capacity is expected to be reached by 1978. According to the company's annual report, the refinery produced 20,000 tons of nickel in 1976.

Table 17.—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.
Carbon black:			
Ashland Chemical Co -----	Box 1503 Houston, Tex. 77005	----do -----	St. Mary.
Cabot Corp -----	125 High St. Boston, Mass. 02110	----do -----	Evangeline and St. Mary
Columbian Carbon Co -----	380 Madison Ave. New York, N.Y. 10017	----do -----	Avoyelles, Ouachita, St. Mary.
Continental Carbon Co -----	Box 22085 Houston, Tex. 77027	----do -----	Calcasieu.
Sid Richardson Carbon & Gasoline Co.	1200 Fort Worth National Bank Bldg. Fort Worth, Tex. 76102	----do -----	West Baton Rouge.
Theratomic Carbon Co., Inc.	245 Park Ave. New York, N.Y. 10017	----do -----	Ouachita.
Cement:			
Lone Star Industries, Inc --	1 Greenwich Plaza Greenwich, Conn. 06830	----do -----	Orleans.
OKC Corp. ^{1,2} -----	Box 10426 Dallas, Tex. 75207	----do -----	Do.
Clays:			
Big River Industries, Inc --	Box 66377 Baton Rouge, La. 70806	Mine and plant ----	Pointe Coupee.
Kentwood Brick & Tile Manufacturing Co., Inc.	Drawer F Kentwood, La. 70444	----do -----	St. Helena.
Gypsum:			
Winn Rock, Inc. ³ -----	Box 790 Winnfield, La. 71483	Mine -----	Winn.
Natural gas and petroleum:³			
Salt:			
Cargill, Inc -----	Cargill Bldg. Minneapolis, Minn. 55402	Underground mine.	St. Mary.
Diamond Crystal Salt Co --	916 Riverside Ave. St. Clair, Mich. 48079	----do -----	Iberia.
The Dow Chemical Co -----	Midland, Mich. 48640 -----	Brine wells -----	Iberville.
International Salt Co -----	Clarks Summit, Pa. 18411 --	Underground mine.	Iberia.
Morton Salt Co -----	110 North Wacker Dr. Chicago, Ill. 60606	----do -----	Do.
PPG Industries, Inc -----	Box 1000 Lake Charles, La. 70604	----do -----	Calcasieu.
Sand and gravel:			
Gifford-Hill & Co., Inc ----	Box 47127 Dallas, Tex. 75247	Plant and dredge --	Jefferson Davis, Tangipahoa, Webster.
Louisiana Sand and Gravel Co.	Box 963 Baton Rouge, La. 70800	----do -----	East Baton Rouge.
Standard Gravel Co., Inc --	Route 4, Box 17 Franklinton, La. 70438	----do -----	Washington.
Stone:			
Lake Charles Dredging & Towing Co.	Lafayette, La. 70501 -----	Dredge -----	St. Mary.
Louisiana Materials Co. ¹ --	Box 8214 New Orleans, La. 70122	----do -----	St. Tammany.
Southern Industries, Inc ----	Drawer 946 Mobile, Ala. 36601	----do -----	Orleans.
Sulfur, native:			
Freeport Minerals Co -----	161 East 42d St. New York, N.Y. 10017	Frasch process ----	Jefferson and Terrebonne.
Texasgulf, Inc -----	200 Park Ave. New York, N.Y. 10017	----do -----	Lafourche.
Sulfur, recovered:			
Cities Service Oil Co -----	Box 300 Tulsa, Okla. 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, Mass. 02140	----do -----	Orleans.

¹ Also clays.² Also stone.³ Most major companies and many smaller companies operate in Louisiana. Commercial directories contain listings of operators.

The Mineral Industry of Maine

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Geology of Maine, for collecting information on all minerals except fuels.

By Herbert R. Babitzke,¹ Edwina F. Bagley,² and Robert G. Doyle³

The value of mineral production in Maine in 1976 was \$40.4 million, a 10% increase over that of 1975, and another new record. There have been yearly production increases since 1971. Major increases were noted for sand and gravel and stone, while copper and zinc production decreased.

Value of manufactured mineral related products was \$834 million in 1976. Total product value of all industries was \$4.2 billion in 1976. (Value of product does not include Kittery Naval Shipyard).⁴

Kerramerican, Inc., completed the fourth year of operation of its zinc-copper mine near Blue Hill. Production cutbacks at zinc converters required the company to continue stockpiling zinc concentrates at the property. Starting October 1976, zinc concentrates were processed by St. Joe Minerals Corp., Monaca, Pa.

A number of U.S. and Canadian companies, at least 10 in number, were exploring for minerals in Maine during 1976. Exploration activities were widespread from Aroostook County to York County. Major interest was in base metals.

The Portland-Monson Slate Co. neared completion of the production shaft at Monson, with production scheduled for 1977.

Lime Products Corp. at Union opened an additional 8 acres for limestone mining providing a grade of limestone needed for the commercial market.

Trends and Developments.—During a

recent investigation by the U.S. Geological Survey, 78 deposits were augered in Aroostook and Washington Counties, resulting in resource estimates of 30 million tons of peat.⁵ In addition, it was estimated that there are at least as many more deposits elsewhere in the two counties and in other parts of eastern Maine. Transportation and marketing are the chief factors influencing the long-range outlook, and the future for a peat industry in Maine appears promising.

The Dickey-Lincoln School Hydroelectric Power Project continued on a steady course of feasibility studies and public hearings with considerable opposition voiced. Two earthfill dams would impound enough water to produce 1.2 billion kilowatt-hours of bulk power for use in New England. The dams would flood over 88,000 acres of land.

The Pittston Co.'s Eastport oil refinery proposal was still under review at yearend. In September, Governor Longley requested the Resource Council of Maine to coordinate a review of the proposal. The Canadian Government does not consider

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³ State geologist, Department of Conservation, Bureau of Geology, Augusta, Maine.

⁴ Maine Department of Manpower Affairs. Census of Maine Manufactures, 1976.

⁵ Cameron, C. C. Some Peat Deposits in Washington and Southeastern Aroostook Counties, Maine. U.S. Geol. Survey Bull. 1317-C, 1975, 40 pp.

Table 1.—Mineral production in Maine ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	125	\$202	134	\$216
Copper (recoverable content of ores, etc.) ----- short tons	2,024	2,599	1,766	2,459
Gem stones ----- W			NA	1,105
Lead ----- short tons	364	157	216	100
Peat ----- thousand short tons	4	207	5	173
Sand and gravel ----- do	9,875	11,403	² 10,312	² 13,950
Stone ----- do	³ 1,253	³ 3,741	1,443	4,609
Zinc (recoverable content of ores, etc.) ----- short tons	8,318	6,488	7,810	5,779
Value of items that cannot be disclosed:				
Cement, feldspar, sand and gravel (industrial, 1976), silver, stone (dimension, 1975), and values indicated by symbol W -----	XX	11,944	XX	11,973
Total -----	XX	36,741	XX	40,364
Total 1967 constant dollars -----	XX	14,538	XX	^P 14,511

^P Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

³ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Maine, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Androscoggin -----	W	W	Sand and gravel, clays.
Aroostook -----	W	W	Sand and gravel, stone
Cumberland -----	W	W	Sand and gravel, stone, clays.
Franklin -----	\$131	\$768	Sand and gravel.
Hancock -----	W	9,195	Zinc, copper, sand and gravel, lead, stone, peat, silver, clays.
Kennebec -----	W	W	Sand and gravel, stone
Knox -----	W	W	Cement, stone, sand and gravel, clays.
Lincoln -----	10	W	Sand and gravel.
Oxford -----	110	569	Sand and gravel, feldspar.
Penobscot -----	W	W	Sand and gravel, stone
Piscataquis -----	W	148	Sand and gravel.
Sagadahoc -----	233	W	Do.
Somerset -----	1,359	846	Do.
Waldo -----	352	537	Sand and gravel, peat.
Washington -----	W	W	Sand and gravel, peat, stone.
York -----	W	1,471	Sand and gravel, stone.
Undistributed ¹ -----	34,493	26,828	
Total ² -----	36,738	40,362	

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 Maine business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	431.5	472.0	+ 9.4
Unemployment ----- do-----	40.4	42.0	+ 4.0
Employment (nonagricultural):			
Mining ----- do-----	(¹)	(¹)	(¹)
Manufacturing ----- do-----	96.3	101.9	+5.8
Contract construction ----- do-----	18.6	21.8	+17.2
Transportation and public utilities ----- do-----	17.7	17.8	+ .6
Wholesale and retail trade ----- do-----	75.7	78.5	+ 3.7
Finance, insurance, real estate ----- do-----	14.2	14.5	+ 2.1
Services ² ----- do-----	59.6	64.2	+ 7.7
Government ----- do-----	74.8	75.1	+ .4
Total nonagricultural employment ----- do-----	356.9	373.8	+ 4.7
Personal income:			
Total ----- millions--	\$5,040	\$5,741	+13.9
Per capita ----- do-----	\$4,764	\$5,366	+12.6
Construction activity:			
Number of private and public residential units authorized--	4,100	4,206	+ 2.6
Value of nonresidential construction ----- millions--	\$161.3	\$46.1	-71.4
Value of State road contract awards ----- do-----	\$23.3	\$30.5	+30.9
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	285	319	+11.9
Mineral production value:			
Total crude mineral value ----- millions--	\$36.7	\$40.4	+10.1
Value per capita, resident population ----- do-----	\$35	\$38	+ 8.6
Value per square mile ----- do-----	\$1,106	\$1,215	+ 9.9

^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.

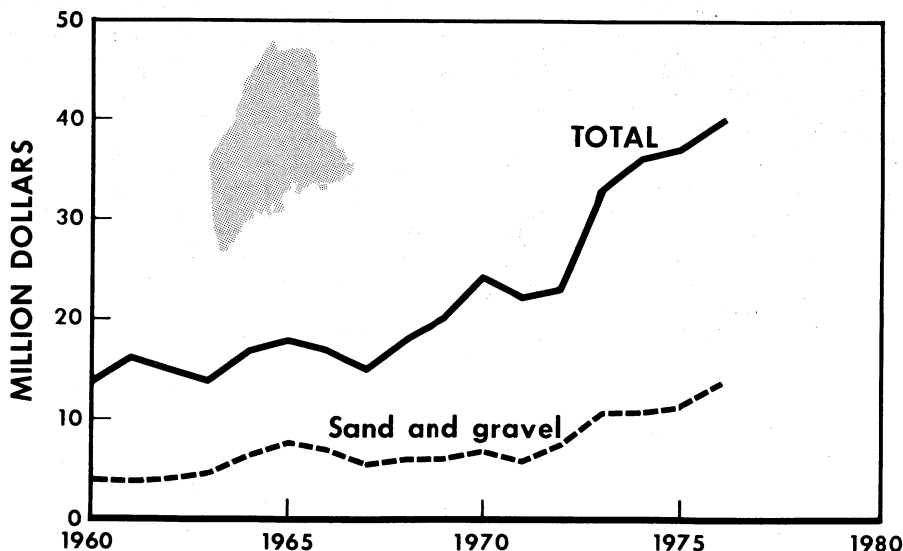


Figure 1.—Value of sand and gravel and total value of mineral production in Maine.

the Pittston plan acceptable because super-tankers would travel through Canadian waters to reach Eastport.

IMC Chemical Group, Inc., at Orrington produced caustic soda, chlorine, hydrochloric acid, and chloropicrin. The raw material, solar salt, was imported from Jamaica.

Legislation and Government Programs.—The Governor called a special session of the legislature to deal with Maine's money problems. One measure affected Maine's only cement plant, Martin Marietta Cement Corp. at Thomaston. A bill was passed that will exempt Martin Marietta from sales tax on any fuel purchased for the manufacture of cement. This could be a savings to the company of approximately \$180,000 per year. The plant has been plagued by expensive oil, Canadian competition, and a depressed building trades industry.

The Land Use Regulation Commission (LURC) adopted a plan to regulate the use of the State's 10 million acres of unorganized wildlands. The plan regulates over half the land mass in Maine, including 56 plantations, 116 coastal islands, and 407 townships where no formal government exists.

The Maine regional planning commissions continued gathering statistics and drafted plans for water quality. The State had five planning agencies that received aggregate grants of \$2.12 million to restore and protect the high-quality water areas under Section 208 of the Federal Water Pollution Control Act of 1972 as amended.

In February 1976, the Governor established a committee on coastal development and conservation by executive order. Since the committee was created, it has focused on the development of Maine's position on leasing, exploration, and development of Outer Continental Shelf oil and gas resources.

A major part of the work was directed toward formulating and carrying out a process for developing an application for program administration under Section 306 of the Federal Coastal Zone Management Act.

The major questions confronting the committee in developing the application were: (1) How should Maine satisfy the Federal requirements for an acceptable 306 application, and (2) what are the highest

priority needs that should be met if funds become available?

The work accomplished during the planning stage has been: (1) Conducting research, (2) data analysis, (3) providing information, (4) providing technical assistance, and (5) developing policy recommendations. The Committee on Coastal Development and Conservation and the State Planning Office were trying to determine local needs regarding land-use planning and management. With this in mind, the State Planning Office held public meetings along the coast and requested information from town, county, and regional officials regarding their needs. The results became the basis for charting the future direction of coastal zone management in Maine.

Mineral Exploration.—A well-planned conceptual exploration program for massive sulfide deposits managed by J. S. Cummings, Inc., Bangor, appears to have made a discovery at Parmachenee in western Maine.⁶ The massive sulfide deposit reportedly contains several million tons of zinc-lead-copper mineralization.

Standard Metals Corp. continued exploration drilling activities in Maine and New Hampshire. The company obtained a 5-year exploration license from the Brown Co. which commenced February 1975, with an option to lease portions of a 240-square-mile tract of land. At yearend, drilling still remained to be done at Red Ridge, south of Umbagog Lake near the New Hampshire border.⁷

Aquitaine Co. of Canada Ltd. continued exploration at Oxbow Township in northern Oxford County. Detailed surveys and drilling were underway to test copper-zinc targets in Ordovician volcanics.⁸

General Crude Oil was acquired by International Paper Co. in 1975 and is aggressively expanding its exploration activity beneath International Paper land where mineral potential is still largely undeveloped.⁹

A number of other companies were involved in exploration around Maine in 1976. Kerr-McGee Corp. appraised the

⁶ Mining Engineering. 1976 Annual Review. V. 28, No. 7, July 1976, p. 51.

⁷ Standard Metals Corp. 1976 Annual Report. 16 pp.

⁸ Aquitaine Co. of Canada Ltd. 1976 Annual Report. P. 4.

⁹ International Paper Co. 1976 Annual Report. 41 pp.

uranium potential along the Maine-New Hampshire border. Phelps Dodge Exploration East, Inc., explored along the coastal mineral belt. The Katahdin massive sulfide deposit, possibly the largest deposit of its kind in the United States, is being evaluated for its nickel potential by Superior Mining Co. Allied Chemical Co. held the deposit for many years as a potential sulfur reserve. Newmont Mining Corp. investigated a molybdenum prospect in southwestern Maine early in the summer. It was re-

ported that Bethlehem Steel has shown interest in the bedded manganese-iron deposits of Aroostook County.

Knox Mining Corp., a subsidiary of Hanna Mining Co., and Basic Inc., both of Cleveland, Ohio, maintained an office at Rockland. There were no drilling programs on the Union Nickel property in Knox County during the year, but research continued on beneficiation of the nickel-copper ore.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Martin Marietta Cement Corp., at its Thomaston plant, decreased production from that of 1975, but value increased. Sales of portland and masonry cement remained essentially unchanged in the company's Eastern Division markets.

Major markets for the cement produced were in Maine, New Hampshire, and eastern Massachusetts. About 48% of the product was for ready-mix customers, 20% was for use in manufactured concrete products, 14% for building material dealers, 11% for highway construction, and 7% for masonry cement. About 85% of the portland cement produced was the gray, general use, and moderate-heat type.

The largest single construction project that made use of the cement manufactured at Thomaston in 1976 was an 18-mile section of I-95 between Topsham and Gardiner.

Clays.—Production of clay in 1976 was 133,617 tons valued at \$216,060, an increase of 7% in quantity and 7% in value. Clays were produced in Androscoggin, Cumberland, Hancock, and Knox Counties. A major percentage was used in cement manufacture and the remainder was consumed in the production of brick.

Feldspar.—Oxford Feldspar Corp. completed its first full year of operation. All feldspar produced was shipped to Massachusetts and New York for use in the manufacture of insulators. The raw material was purchased from independent miners in Oxford County and ground in the mill at West Paris.

Gem Stones.—Western Maine is an area of considerable interest for collectors and

rockhounds. Many of the feldspar quarries offered a vast collector's paradise. Some of the quarries have been in existence for a hundred years, and some were being mined during the year. Plumbago Mining Corp. did some mining during the year, but most of the material marketed was from the discovery in 1972 and 1973.

Graphite, Synthetic.—Filer Materials, Inc., of York County produced synthetic graphite during the year. All the production went to refractories and cloth.

Peat.—There were three companies that produced peat in Maine in 1976. Pioneer Peat Moss Co. and International Peat Moss Co., Inc., both operated in Washington County. Acadia Peat Corp. did not produce in 1976 but sold from stock. The peat was mined, dried, packaged, and sold for soil conditioning. Deer Hill Farms, Inc., produced peat humus, which was blended and sold as high-quality potting soil.

Another peat bog will be open to mining. Maine's Department of Environmental Protection (DEP) approved the application to mine 1 acre annually. The bog is a 230-acre area off Flag Pond Road near Saco.

Perlite.—Chemrock Corp. expanded crude perlite from New Mexico at its plant near Thomaston. Marine Colloids Inc., which uses most of the expanded perlite as a filter aid, had a net income and sales increase of 16% and 8%, respectively. Marine Colloids produces carrageen from seaweed.

Sand and Gravel.—Production of construction sand and gravel was 10.3 million tons valued at \$14 million, an increase of 4% in quantity and 22% in value over

that of 1975. A total of 113 companies and government-and-contractor operations were active during the year producing from 148 pits. Leading producing counties in order were Penobscot, followed by Cumberland, Aroostook, and Kennebec. About 55% was used on government projects and the remaining for commercial projects. Use

distribution was 27% for concrete aggregate, 16% for bituminous paving, 29% for roadbase stone, 13% for fill, and 15% other.

During the year, 12.2 miles of interstate highway projects were started and 15.3 miles were completed.

Table 4.—Maine: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Androscoggin -----	10	735	1,306	17	627	1,138
Aroostook -----	5	736	533	8	1,153	1,372
Cumberland -----	14	1,500	1,835	18	1,350	2,039
Franklin -----	3	162	131	7	468	768
Hancock -----	4	332	369	10	503	743
Kennebec -----	8	332	767	11	1,013	876
Knox -----	4	635	1,024	5	448	724
Lincoln -----	1	40	10	2	W	W
Oxford -----	4	207	110	9	407	543
Penobscot -----	10	2,309	1,117	17	1,529	2,115
Piscataquis -----	4	58	72	5	211	148
Sagadahoc -----	3	319	283	2	W	W
Somerset -----	6	1,331	1,331	6	589	846
Waldo -----	5	331	352	10	474	536
Washington -----	5	228	208	8	371	300
York -----	11	621	952	13	858	1,457
Undistributed -----	--	--	--	--	311	346
Total ¹ -----	97	9,876	11,400	148	10,312	13,950

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

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

Table 5.—Maine: Construction sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1976	
	Quantity	Value
Sand -----	5,715	5,580
Gravel -----	4,597	8,369
Total -----	10,312	¹13,949

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

Table 6.—Maine: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate:				
Residential and nonresidential, highways, bridges, dams, waterworks, airports, etc.	911	2,069	2,046	2,689
Concrete products (cement blocks, bricks, pipe, etc.)	111	293	786	2,694
Asphaltic concrete aggregates and other bituminous mixtures	1,867	3,366	1,681	3,237
Roadbase and coverings	3,343	2,555	2,956	2,134
Fill	2,614	2,001	1,307	1,565
Other	1,029	1,120	1,534	1,630
Total ¹	9,875	11,404	10,310	13,949

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

Stone.—During the year there were 16 quarries operating in eight counties, and production of stone increased 15% over that of 1975 and the value increased 23%. Knox County led production with 48% of the stone quarried, followed by Cumberland with 33%. Over half of the crushed limestone was used for agricultural limestone, bituminous aggregate, concrete aggregate, railroad ballast, and other. All the marl was for agriculture. The dimension granite was for rough block and monumental use. Crushed and broken granite was for riprap and jetty and filter stone. Most of the crushed and broken sandstone was used for concrete aggregate, bituminous aggregate, and roadbase. The traprock was mostly for concrete aggregate.

About 250 tons of Deer Island Granite was shipped off Crotch Island for an addition to the Rockefeller Center in New York City. The last granite was quarried 13 years ago for the John F. Kennedy Memorial at the National Cemetery in Arlington, Va.

The Portland-Monson Slate Co. at Monson continued work on the production shaft. Production is scheduled to begin in 1977.

Eight additional acres were opened for mining by Lime Products Corp. at Union. The company sells both commercial and agricultural lime products, and the new quarry will provide a grade of limestone needed for the commercial market.

METALS

The Blue Hill mine was the only metal mine in the State. This Kerramerican, Inc.,

mine and mill is located in Hancock County, near Blue Hill, and in 1976 the company completed its fourth full year of operation. Black Hawk Mining Ltd. has a 40% interest through its subsidiary, Black Hawk Corp. Kerr Addison Mines Ltd. owns the other 60%. Operations were managed by the U.S. subsidiary of the joint-venture partner, Kerramerican, Inc.

The company produced 176,100 tons of ore at average grades of 1.2% copper and 5.1% zinc. Copper production was 1,766 tons (recoverable content in ore), a decrease of 13% from that of 1975. The copper concentrates were sent to the Noranda Mines Ltd. Gaspé smelter at Murdochville, Quebec. Minor values of silver and lead were carried with the copper concentrate. Zinc production was 7,810 tons (recoverable content in ore), a decrease of 6% from that of 1975. Due to production cutbacks at zinc converters, the zinc concentrate stockpile at the property increased from 7,150 tons at yearend 1975 to 10,700 tons on December 31, 1976. Effective October 1976, zinc concentrates were being processed by St. Joe Minerals Corp., Monaca, Pa. Previously they were processed by National Zinc Co., Bartlesville, Okla.

Minable reserves including an allowance for dilution were estimated on December 31, 1976, at 219,000 tons with average grades of 1.46% copper and 3.20% zinc. In this estimate, 185,700 tons at grades of 1.2% copper and 3.7% zinc has been deleted from the reserves of the previous year. This ore occurs below the Carlton Fault and was classified uneconomic

because it would necessitate considerable development.

There was further review of the Carlton Zone, south of the shaft, where extensive mineralization has been partially defined at greater depth than existing workings. Economic feasibility for developing and mining the area was well under review at yearend. The Carlton Zone was not included in the statement of minable reserves.¹⁰

The American Hoist and Derrick Co. in Portland consumed zinc at about the same level as in the previous year. Numerous parts produced in their foundry were hot-dip galvanized according to customer specifications.

Schiavone of Maine, a division of Michael Schiavone and Sons, Inc., purchased National Metal Converters, Inc., of Leeds in March. This was the only company in Maine that shreds junk automobiles and other scrap. The company produced an average of 2,000 tons of scrap iron per month. Most of the ferrous scrap produced was destined for the foreign markets.

Philips Elmet Corp., Lewiston, continued importing tungsten and molybdenum and producing tungsten and molybdenum wire and parts using powder metallurgy techniques. About half of the finished products were used within the North American Philips Corp. electronics industry.

MINERAL FUELS

There was no production of fossil fuels in Maine in 1976. Energy from wood has become increasingly important, and since Maine is covered with vast forests, wood has helped satisfy a very important need.

The Maine Office of Energy Resources published a comprehensive energy plan which includes the following: (1) A description and quantification of the present supply, rates of use and energy needs of the State; (2) a description and quantification of the projected needs, rates of use, and availability of various energy resources to meet future State needs; (3) discussions of the economic implication of various future energy development, (4) a development of three alternative scenarios for possible energy futures, each one of which has an equal probability of occurrence and

which will in turn depend on present or future policy decisions.

The State consumed 6.9 billion kilowatt-hours of electricity in 1976, an increase of 9% over that of 1975. In addition, fuel oil consumption was 38 million barrels, of which 9 million barrels were used for generation of electricity. The consumption of fuel oil was down as a result of nuclear generation at Maine Yankee with 2.95 billion kilowatt-hours for a savings of 5.2 million barrels of oil.

New or additional electric generating projects proposed or under construction are the W. F. Wyman Unit No. 4, Brunswick Topsham hydroelectric project, Sears Island coal plant, and the Cold Stream hydroelectric project.

The Portland-Montreal pipeline system transported 140.2 million barrels of crude oil in 1976 through its three pipelines from south Portland to the Montreal, Canada, refineries.

The U.S. Army Corps of Engineers accelerated efforts to assess the environmental impact of the proposed Dickey-Lincoln hydroelectric project in northern Maine. A contract was let to Edward C. Jordan, Inc., of Portland to study the socioeconomic impact of the project. Earlier studies focused chiefly on physical changes expected. In June, the U.S. House of Representatives passed a public works bill which included \$2 million for crucial environmental impact studies. If constructed, the Dickey-Lincoln project would be capable of supplying over 1 billion kilowatt-hours of electricity annually to New England during periods of peak demand. Attached to the public works bill was \$500,000 for more studies of the Passamaquoddy Tidal Power Project. Subsequently, the Corps of Engineers was authorized \$2.95 million for more studies on the tidal project.

Pittston Co. officials prepared an environmental assessment report on the Eastport oil refinery to be part of an environmental impact statement by the Federal Environmental Protection Agency (EPA). The environmental impact statement by EPA received strong criticism from the Maine Land and Water Resources Council,

¹⁰ Kerr Addison Mines Ltd. 1976 Annual Report, pp. 4 and 10.

Black Hawk Mining Ltd. 1976 Annual Report, 8 pp.

a group composed of State officials, legislators, and planning specialists. The council had been asked by the Governor to issue a report regarding the Eastport site. The Pittston plan was debated for more than 2 years by the Maine DEP, which

granted a conditional site location permit in 1975. The unresolved question was the steadfast opposition by the Canadian Government to the use of supertankers in Head Harbour Passage between two New Brunswick islands which lead to the refinery site.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Martin Marietta Cement Corp., Eastern Div. ¹	11300 Rockville Pike Rockville, Md. 20852	Quarry and plant	Knox.
Clays:			
Dennis Brick Co., Inc	Mt. B Washington St. Auburn, Maine 04210	Pit and mill	Androscoggin.
LaChance Brick Co., a division of Morin Brick Co.	Mosher Rd. Gorham, Maine 04038	do	Cumberland.
Morin Brick Co	Danville, Maine 04223	do	Androscoggin.
Rowantrees, Inc	Union St. Blue Hill, Maine 04614	Pit	Hancock.
Royal River Brick Co., Inc	Box 191 Gray, Maine 04039	Pit and mill	Cumberland.
Watershed Corp	Edgecomb, Maine 04545	Plant	Lincoln.
Feldspar:			
Oxford Feldspar Corp	Box 115A W. Paris, Maine 04289	Mill	Oxford.
Peat:			
Acadia Peat Corp	Penobscot, Maine 04476	Bog and plant	Hancock.
Deer Hill Farms, Inc	Weeks Mills, Maine 04361	Bog	Franklin.
International Peat Moss Co., Inc.	430 Trapelo Rd. Belmont, Mass. 02178	Bog and plant	Washington.
Pioneer Peat Moss Co	Centerville, Maine 04649	do	Do.
Perlite (expanded):			
Chemrock Corp	End of Osage St. Nashville, Tenn. 37208	Plant	Knox.
Sand and gravel:			
Blue Rock Industries	58 Main St. Westbrook, Maine 04092	5 pits and mills	Androscoggin, Cumberland, Franklin, York.
Cianbro Corp	Box D Pittsfield, Maine 04967	7 pits and mills	Franklin, Hancock, Oxford, Penobscot, Somerset.
G. E. Goding & Son, Inc	Route 1, Box 78A Lincoln, Maine 04457	2 pits and plants	Penobscot.
D. J. Gurney, Inc	Route 1, River Rd. Waterville, Maine 04901	2 pits and mills	Kennebec and Somerset.
George C. Hall Excavating	Box 506 Rockland, Maine 04841	2 pits and plant	Knox.
Lane Construction Corp	965 E. Main St. Bangor, Maine 04401	4 pits and mills	Aroostook, Penobscot, Waldo, Washington.
Harold C. MacQuinn, Inc	Bar Harbor, Maine 04609	Pit and mill	Hancock.
R. Pepin & Son, Inc	Route 1, Box 547 Sanford, Maine 04073	do	York.
Portland Sand and Gravel Co., Inc.	Gray Rd. Cumberland, Maine 04021	do	Cumberland.
H. E. Sargent, Inc	101 Bennoch Rd. Stillwater, Maine 04489	7 pits and mills	Kennebec, Penobscot, Sagadahoc, Somerset.
Warren Bros. Co	Fairfield, Maine 04937	5 pits and mills	Cumberland, Penobscot, Somerset, York.
Williams Construction Co	Brunswick Rd. Gardiner, Maine 04345	Pit and mill	Kennebec.
Williams Materials Co	do	do	Do.

See footnotes at end of table.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Granite, dimension:			
The John Swenson Granite Co., Inc.	North State St. Concord, N.H. 03301	3 quarries -----	Hancock and York.
Limestone, crushed:			
Blue Rock Industries --	58 Main St. Westbrook, Maine 04092	-----do -----	Cumberland and Kennebec.
Lane Construction Corp	965 E. Main St. Bangor, Maine 04401	Quarry -----	Aroostook.
Lime Products Corp ---	Box 357 Union, Maine 04862	Quarry and mill --	Knox.
Marine Trading and Transportation Co.	Box 449 Rockland, Maine 04841	-----do -----	Do.
Marl:			
Stanley Giles -----	17 Mechanic Rd. Presque Isle, Maine 04769	-----do -----	Aroostook.
Miscellaneous stone:			
Cianbro Corp -----	Box D Pittsfield, Maine 04967	7 pits and mills --	Franklin, Hancock, Oxford, Penobscot, Somerset, Cumberland.
Cook Concrete Co ----	960 Ocean Ave. Portland, Maine 04103	Quarry -----	Cumberland.
Thomas DiCenzo, Inc --	75 Barker St. Calais, Maine 04619	-----do -----	Washington.
Hughes Bros., Inc ----	Box 565 Bangor, Maine 04401	2 pits and mill ---	Penobscot and Waldo.
Slate:			
Portland-Monson Slate Co.	Monson, Maine 04464 -----	Underground mine and plant.	Piscataquis.
Zinc:			
Kerramerican, Inc. ² -----	Box N Blue Hill, Maine 04614	Mine and plant ---	Hancock.

¹ Portland and masonry.² Also produced copper, lead, silver.

The Mineral Industry of Maryland

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting information on all minerals in the State.

By Joseph A. Sutton ¹ and Marilyn N. Dimmitt ²

Maryland's mineral production increased in value in 1976 to \$185 million, about 12% above the \$165 million for 1975. The increase was brought about mostly by value increases for coal and stone.

Bituminous coal was again the most valuable mineral commodity produced in the State and accounted for about 33% of the State's mineral wealth. In response to increased demand for fuel, coal production was 9% above that of 1975.

Stone continued to be the second most valuable mineral commodity produced and accounted for 26% of the State's mineral wealth. The total value of stone produced in 1976 was \$47.7 million, 11% above the 1975 value of \$43.1 million.

Sand and gravel contributed 17% to the mineral wealth of the State. Production of sand and gravel increased about 10% to 12.9 million tons, and value increased 8% to \$31.9 million.

Portland and masonry cement contributed significantly to the economy of the State, but actual figures must be concealed to avoid disclosing company proprietary data. However, there were modest increases in both tonnage and value of cement in 1976.

¹ State Liaison Officer—Maryland and Delaware, Bureau of Mines, Washington, D.C.

² Program assistant—Maryland and Delaware, Bureau of Mines, Washington, D.C.

Table 1.—Mineral production in Maryland ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ²thousand short tons..	580	\$1,450	702	\$1,817
Coal (bituminous)do.....	2,606	50,502	2,830	61,974
Limedo.....	15	434	16	494
Natural gasmillion cubic feet..	93	25	75	24
Peatthousand short tons..	2	39	2	W
Sand and graveldo.....	11,786	29,477	12,942	31,914
Stonedo.....	14,796	43,110	15,709	47,669
Value of items that cannot be disclosed:				
Cement, clays (ball), gem stones, and values indicated by symbol W	XX	39,882	XX	41,026
Total	XX	164,919	XX	184,918
Total 1967 constant dollars	XX	65,258	XX	^p 66,478

^p Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed."

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

² Excludes ball clay; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Maryland, by county ¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Allegany -----	W	W	Coal, stone.
Anne Arundel -----	\$3,118	\$3,118	Sand and gravel.
Baltimore ² -----	W	W	Stone, sand and gravel, clays.
Caroline -----	--	3	Sand and gravel.
Carroll -----	W	W	Cement, stone, clays.
Cecil -----	8,693	10,395	Stone, sand and gravel.
Charles -----	W	W	Sand and gravel.
Dorchester -----	372	W	Do.
Frederick -----	W	W	Cement, stone, clays, lime.
Garrett -----	W	W	Coal, stone, sand and gravel, peat.
Harford -----	W	W	Stone, sand and gravel, clays.
Howard -----	W	1,322	Stone.
Kent -----	W	W	Clays.
Montgomery -----	5,765	W	Stone.
Prince Georges -----	11,464	14,264	Sand and gravel, clays.
St. Marys -----	W	254	Sand and gravel.
Washington -----	W	W	Cement, stone, clays.
Wicomico -----	W	W	Sand and gravel.
Worcester -----	395	860	Do.
Undistributed ³ -----	135,111	154,702	
Total -----	164,919	⁴ 184,918	

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

¹ Calvert, Queen Annes, Somerset, and Talbot Counties are not listed because no production was reported.

² Includes Baltimore City.

³ Includes some natural gas, gem stones, and values indicated by symbol W.

⁴ Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Maryland business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,842	1,900	+3.1
Unemployment ----- do-----	127	128	+ .8
Employment (nonagricultural):			
Mining ----- do-----	1.7	1.8	+5.9
Manufacturing ----- do-----	230.7	231.6	+ .4
Contract construction ----- do-----	90.9	93.7	+3.1
Transportation and public utilities ----- do-----	78.3	78.1	-.3
Wholesale and retail trade ----- do-----	355.3	362.3	+2.0
Finance, insurance, real estate ----- do-----	79.8	80.1	+ .4
Services ----- do-----	279.6	288.0	+3.0
Government ----- do-----	366.0	371.9	+1.6
Total nonagricultural employment ----- do-----	1,482.3	1,507.5	+1.7
Personal income:			
Total ----- millions--	\$26,117	\$28,514	+9.2
Per capita -----	\$6,336	\$6,880	+8.6
Construction activity:			
Number of private and public residential units authorized--	19,661	26,994	+37.3
Value of nonresidential construction ----- millions--	\$306.6	\$365.5	+19.2
Value of State road contract awards ----- do-----	\$92.2	\$98.0	+6.3
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,196	1,289	+7.8
Mineral production value:			
Total crude mineral value ----- millions--	\$164.9	\$184.9	+12.1
Value per capita, resident population -----	\$40	\$45	+12.5
Value per square mile -----	\$15,592	\$17,483	+12.1

^P Preliminary.

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.—During the 1976 regular session of the General Assembly of Maryland there were a number of amendments and additions to the National Resources Article covering open pit mining on State land and deep-mining control. Among these were amendments to Section 7-505b authorizing the Secretary of Natural Resources to issue or renew an open pit mining permit on State lands if in conjunction with the reclamation of abandoned mines (Senate Bill 575) and public construction projects (Senate Bill 602). A new Section 7-5A01 through 7-5A15 provided for licensing and regulating underground mining operations and owners, and guaranteed reclamation of land surface affected by deep-mining operations.

The Department of the Interior held its first Outer Continental Shelf oil and gas lease sale in August 1976. However, the issuance of leases to oil companies willing to pay \$1.1 billion in bonus bids was held up during the year by a lawsuit filed by local governments and environmental groups.

A Particulate Mineralogy Unit was established at the Federal Bureau of Mines Metallurgy Research Center, College Park. The unit was established to identify particulates connected with environmental problems related to the activities of a number of Federal regulatory agencies. During the year attempts were made by the unit to clarify the ambiguities surrounding the mineralogy of and terminology used for asbestiform minerals and other mineral particles.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Output of portland and masonry cement was 1% above that of 1975, and the overall value was up 3%.

Clays.—Clay production (excluding ball clay) increased 21% in tonnage, to 702,000 short tons in 1976; value was \$1,817,000, 25% above that of 1975. About 94% of the clay produced in the State was used to make brick and other clay products, and most of the clay was mined in Frederick, Washington, and Prince Georges Counties.

Gem Stones.—Production of semiprecious stones was limited to small quantities collected by dealers and amateur collectors.

Gypsum.—United States Gypsum Co. and National Gypsum Co. calcined gypsum at Baltimore in Baltimore County. The quantity and value of output in 1976 increased 26% and 37% respectively over the 1975 totals.

Lime.—S. W. Barrick & Sons, Inc., produced lime in Frederick County for agricultural purposes in 1976. Output increased 7% above the 1975 level. The lime was consumed in Maryland, Virginia, Delaware, and Pennsylvania.

Peat.—Only one company produced peat in Maryland in 1976, and its output was the same as in 1975. The peat was sold in both bulk and packaged form for soil improvement.

Perlite.—Relatively small amounts of crude perlite from the Western United States were processed in 1976 at a plant in Baltimore County. The expanded perlite produced was utilized as aggregates in plaster.

Sand and Gravel.—Production of sand and gravel increased 1.2 million tons to 12.9 million tons, reflecting the increase in construction activity that took place during the year. Sand and gravel used for commercial purposes accounted for 73% of the total output, and sand and gravel used for government purposes accounted for the remainder. The average unit value of sand and gravel was \$2.47 per ton, 3 cents below that of 1975. The major part of the sand and gravel used for commercial purposes went into building and highway construction; the remainder was used for fill and miscellaneous purposes.

The four top-ranking counties, in order of production of sand and gravel, were Prince Georges, Cecil, Anne Arundel, and Baltimore.

Legislation (HB 1867) was introduced into the General Assembly which would impose a severance tax on the removal of sand and gravel from certain lands in the State by commercial producers. It was reviewed by committee, but was not reported out of committee.

Table 4.—Maryland: Construction sand and gravel sold or used¹ in 1976
(Thousand short tons and thousand dollars)

Use	Quantity	Value
Construction:		
Sand -----	8,310	19,148
Gravel -----	4,631	12,766
Total -----	² 12,942	31,914

¹ Sand and gravel figures for 1976 cannot be compared with 1975 data because of the new canvassing format used.

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

Stone.—Eight companies quarried dimension stone for rough construction, rubble, house stone veneer, and other uses. Dimension stone output increased about 10% to 25,560 tons valued at \$699,200. Leading producers were Stoneyhurst Quarries and M and S Stone Quarries. Crushed stone was produced by 24 companies at 32 quarries for roadstone, bituminous aggregate, cement, and other uses. Output increased 6% to 15,683,000 tons valued at \$47 million. Leading stone producers were The Flintkote Co., Rockville Crushed Stone, Inc., and Lehigh Portland Cement Co.

Among the States, Maryland led in output of dimension miscellaneous stone and ranked fifth in dimension sandstone.

Talc.—Harford Talc Co. ceased talc mining in Harford County in 1974. How-

Table 5.—Maryland: Construction sand and gravel sold or used in 1976, by major use category¹

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Concrete aggregate (non-residential, residential, highways, bridges, dams, waterworks, airports, etc.) -----	5,130	14,068
Concrete products (cement blocks, bricks, pipe, etc.) -----	1,975	5,299
Asphaltic concrete aggregates and other bituminous mixtures -----	736	1,846
Roadbase and coverings -----	3,554	7,674
Fill -----	873	1,503
Other uses -----	671	1,524
Total -----	² 12,942	31,914

¹ Sand and gravel figures for 1976 cannot be compared with 1975 data because of the new canvassing format used.

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

ever, the company imported crude talc from Africa and the Western United States and processed it for use in the manufacture of electrical insulators.

Vermiculite (Exfoliated).—Dimension Construction Products of W. R. Grace & Co., Prince Georges County, processed raw vermiculite into the exfoliated product at Muirkirk. The finished material was utilized primarily for concrete aggregates and for fireproofing.

Table 6.—Maryland: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Roadstone -----	4,434	11,760	4,971	14,120
Bituminous aggregate -----	2,454	6,114	2,361	6,494
Cement manufacture -----	1,868	2,331	2,092	2,533
Concrete aggregate -----	1,886	5,240	1,733	5,073
Macadam aggregate -----	1,596	4,711	1,658	4,993
Dense-graded roadbase stone -----	1,534	4,008	1,506	4,520
Riprap and jetty stone -----	243	850	400	1,485
Surface treatment aggregate -----	269	733	294	850
Railroad ballast -----	110	244	169	411
Lime manufacture -----	W	W	32	74
Other uses ² -----	379	6,505	469	6,490
Total ³ -----	14,772	42,498	15,683	47,000

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

¹ Includes limestone, traprock, granite, miscellaneous stone, and sandstone.

² Includes stone used in whitening, soil conditioning, agricultural limestone, refractory stone, abrasives, other fillers and extenders, mineral food, filter stone (1976), asphalt filler (1976), flux stone, other uses, and uses indicated by symbol W.

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

MINERAL FUELS

Coal (Bituminous).—Production of bituminous coal in 1976 increased to 2,830,000 tons, about 9% above that of 1975. The coal was mined from six basins in the extreme western portion of Maryland. About 48% of the production came from the George's Creek Basin, 26% from the Potomac Basin, and 25% from the Casselman and the lower and upper Youghiogheny Basins. According to the Department of Energy there were 29 coal mines in Allegany County and 35 in Garrett County. Two of these mines were underground, 5 were auger-type mines, and 57 were open pit mines.

Surface mines accounted for 86% of the coal produced; underground mines, 6%; and auger mines, 8%.

In 1976, the acreage eligible for revegetation bond release totaled 961, of which 668 acres were released. The reasons for the large number of acres eligible for bond release follow: More acres were strip-mined in 1974, and many acres that did not meet the revegetation specifications were being held from previous years. The Land Reclamation Committee requires that vegetation go through two growing seasons before the planting is approved and that at least 80% cover of vegetation must be established in order for it to be approved. Saving topsoil and spreading it on the backfilled site has greatly improved the success of vegetation growth on the reclaimed sites.³

Coke and Coal Chemicals.—Bethlehem Steel Corp. produced coke for internal use at Sparrows Point. Byproducts recovered from the distillation of coal included oven coke gas, ammonia, crude light oil, benzene, toluene, xylene, oven coke tar, and other minor components in addition to the primary product, coke.

Natural Gas and Petroleum.—Natural gas production from fields in Garrett County during 1976 was 75 million cubic feet, a decrease of 19% from the 1975 production.

Columbia LNG Corp., a subsidiary of Columbia Gas System, Inc., was having a

liquefied natural gas import terminal constructed near Cove Point. The terminal, to be completed in 1977, had a designed send-out capacity of approximately 1 billion cubic feet of gas per day. Liquefied natural gas arriving from Algeria and stored at the terminal is to be regasified and transported by pipeline to markets served by the Columbia Gas System, Inc., and Consolidated Natural Gas Co.

Two small petroleum refineries near Baltimore converted crude oil into asphalt products, but none of the feedstock originated in Maryland.

METALS

Aluminum.—No bauxite or other aluminum ore was mined in Maryland, but there was a significant production of metallic aluminum at two facilities in the State, Eastalco Aluminum Co. (Howmet Corp.) in Frederick County and Tomke Aluminum Co. in Baltimore County.

Copper.—With the closing of the ASARCO, Inc., refinery in Baltimore in 1975, the Kennecott Refining Co. at Hawkins Point was the only plant operating in Maryland in 1976.

ASARCO opened a new 420,000-ton-capacity copper refinery at Amarillo, Tex., in 1976 to replace the older plants closed at Baltimore and at Perth Amboy, N.J.

Iron and Steel.—Bethlehem Steel Corp. at Sparrows Point continued to produce pig iron, raw steel, and semifabricated steel products from imported ore. A sinter plant was placed in full operation at Sparrows Point in 1976. It was designed to produce annually approximately 3.9 million tons of fluxed sinter for the blast furnaces from iron ore fines, flue dust, mill scale, iron-bearing pollution control sludges and dust, basic oxygen furnace slag, and limestone fines. This new single unit replaces six existing units.⁴

Lead.—Lead, lead alloys, and other alloys and products were produced at three plants in Baltimore. The plants utilized primary metals and scrap as raw materials.

³ Maryland Bureau of Mines. Annual Report, 1976.

⁴ Bethlehem Steel. 1976 Annual Report.

Table 7.—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 -----	Frederick.
Lehigh Portland Cement Co. ²	718 Hamilton St. Allentown, Pa. 18101	---do -----	Carroll.
Portland and masonry: Marquette Cement Manufacturing Co. ¹	First American Center Nashville, Tenn. 37238	---do -----	Washington.
Masonry: M. J. Grove Lime Co. ¹	Frederick, Md. 21701	---do -----	Frederick.
Clays:			
Baltimore Brick Co -----	501 St. Paul Pl. Baltimore, Md. 21202	Pits -----	Baltimore and Frederick.
Cyprus Industrial Materials Co.	555 South Flower St. Los Angeles, Calif. 90071	Pit -----	Baltimore.
Victor Cushwa & Sons, Inc.	201 West Potomac St. Williamsport, Md. 21795	Pit -----	Washington.
Coal:			
Buffalo Coal Co -----	Box 275 Bayard, W. Va. 26707	5 strip mines ----	Garrett.
Grafton Coal Co -----	Box 188 Mt. Lake Park, Md. 21550	3 strip mines ----	Do.
Moran Coal Co., Inc -----	Drawer E Westernport, Md. 21562	Strip mine -----	Do.
Winner Brothers Coal Co., Inc.	Box 300 Frostburg, Md. 21532	5 strip mines ----	Allegany.
Gypsum (calcined):			
National Gypsum Co -----	325 Delaware Ave. Buffalo, N.Y. 14202	Plant -----	Baltimore.
United States Gypsum Co --	101 South Wacker Dr. Chicago, Ill. 60606	---do -----	Do.
Iron oxide pigments, finished (natural and manufactured):			
Minerals Pigments Corp --	7011 Muirkirk Rd. Beltsville, Md. 20705	---do -----	Prince Georges.
Lime: S. W. Barrick & Sons, Inc.	Woodsboro, Md. 21798	---do -----	Frederick.
Peat: Garrett County Processing & Packaging Corp.	R.F.D. No. 1 Accident, Md. 21520	Bog -----	Garrett.
Petroleum refineries:			
Amoco Oil Co -----	910 South Michigan Ave. Chicago, Ill. 60680	Refinery -----	Baltimore.
Chevron Asphalt Co -----	Baltimore, Md. 21200	---do -----	Do.
Sand and gravel:			
Campbell Sand and Gravel, Inc.	4911 Calvert Rd. College Park, Md. 20740	Pit -----	Prince Georges.
Charles City Sand & Gravel Co., Inc.	Waldorf Industrial Center Box 322 Waldorf, Md. 20601	Dredges -----	Charles.
Contee Sand & Gravel Co., Inc.	Box 460 Laurel, Md. 20810	Pit -----	Prince Georges.
Harry T. Campbell Sons Co., Div. of Flintkote Co.	Towson, Md. 21225	Pits -----	Baltimore.
York Building Products Co., Inc.	Box 1708 York, Pa. 17405	Pit -----	Cecil.
Stone:			
Arundel Corp -----	501 St. Paul Pl. Baltimore, Md. 21202	Quarries -----	Baltimore, Harford, Howard, Washington.
Martin-Marietta Aggregates.	66 Long Clove Rd. Congers, N.Y. 10920	Quarry -----	Washington.
Maryland Materials, Inc ---	Box W North East, Md. 21901	---do -----	Cecil.
Rockville Crushed Stone, Inc.	Box 407 Rockville, Md. 20850	---do -----	Montgomery.
D. M. Stoltzfus & Sons, Inc.-	Talmage, Pa. 17580	Quarries -----	Cecil and Harford.

¹ Also stone.² Also clays and stone.

The Mineral Industry of Massachusetts

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the State Geologist of the Commonwealth of Massachusetts for collecting information on all minerals except fuels.

By William R. Barton¹ and Joseph A. Sinnott²

The value of minerals produced in Massachusetts increased 19% during 1976. The 1976 value of \$69.8 million, compared with \$58.8 million in 1975, was the result of quantitative increases reported for all major mineral products.

Minerals produced in Massachusetts amount to only about 7,000 pounds for each citizen compared with national per capita requirements of 40,000 pounds per year including mineral fuels. The State is self-sufficient only in sand and gravel and most varieties of stone. It must entirely import mineral requirements for metals and chemical raw materials, mineral fuels, and many nonmetallic minerals. The State is dependent upon mineral fuels produced elsewhere for its annual energy requirement of approximately 1,300 trillion Btu.

The energy mix is derived 83% from petroleum products including gasoline, 12% from natural gas, 3% nuclear, and 2% coal. Of all manufacturing activity in Massachusetts, 11% involves production of chemical, stone, clay, glass, and primary metals from mineral products. An additional 41% of manufacturing involves fabrication of metal products, machinery, electrical, electronic, and transportation equipment made largely of mineral derived materials. In addition, most construction is largely based upon use of mineral derived products.

Legislation and Government Programs.—A bill to regulate coal mining in

¹ State Liaison Officer, Bureau of Mines, Newmarket, N.H.

² Massachusetts State geologist, Boston, Mass.

Table 1.—Mineral production in Massachusetts¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons--	124	\$228	126	\$238
Lime -----do-----	152	5,215	178	6,354
Sand and gravel -----do-----	13,281	24,556	16,084	29,666
Stone -----do-----	7,170	28,681	7,937	33,502
Value of items that cannot be disclosed:				
Other nonmetals -----	XX	166	XX	90
Total -----	XX	58,846	XX	69,850
Total 1967 constant dollars -----	XX	23,285	XX	^p 25,111

^p Preliminary. XX Not applicable.

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

Table 2.—Value of mineral production in Massachusetts, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Barnstable	\$1,267	\$1,111	Sand and gravel.
Berkshire	12,126	15,870	Stone, lime, sand and gravel.
Bristol	3,849	5,316	Sand and gravel, stone.
Dukes	W	105	Sand and gravel.
Essex	5,524	6,734	Stone, sand and gravel.
Franklin	W	W	Sand and gravel, stone.
Hampden	W	W	Stone, sand and gravel.
Hampshire	W	W	Sand and gravel, stone.
Middlesex	W	15,232	Stone, sand and gravel.
Nantucket	--	W	Sand and gravel.
Norfolk	W	W	Stone, sand and gravel, clays.
Plymouth	W	W	Sand and gravel, clays, stone.
Suffolk	W	W	Stone.
Worcester	W	W	Sand and gravel, stone, peat.
Undistributed ¹	36,080	25,483	
Total	58,846	² 69,850	

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

¹ Includes gem stones.

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

Table 3.—Indicators of Massachusetts business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force	2,735	2,762	+1.0
Unemployment	305	268	-13.8
Employment (nonagricultural):			
Mining	(¹)	(¹)	(¹)
Manufacturing	577.8	592.9	+2.6
Contract construction	79.8	71.6	-10.3
Transportation and public utilities	113.7	112.1	-1.4
Wholesale and retail trade	511.8	521.1	+1.8
Finance, insurance, real estate	135.1	135.2	+1
Services ²	489.1	509.7	+4.2
Government	365.1	366.5	+4
Total nonagricultural employment	2,272.4	2,309.1	+1.6
Personal income:			
Total	\$35,156	\$38,272	+8.9
Per capita	\$6,046	\$6,588	+9.0
Construction activity:			
Number of private and public residential units			
Value of nonresidential construction	17,984	18,201	+1.2
Value of State road contract awards	\$339.4	\$354.4	+4.4
Shipments of portland and masonry cement to and within the State	\$145	\$120	-17.2
Mineral production value:	948	846	-10.8
Total crude mineral value			
Value per capita, resident population	\$58.8	\$69.8	+18.7
Value per square mile	\$10	\$12	+20.0
	\$7,127	\$8,459	+18.7

^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.

Table 4.—Worktime and injury experience in the Massachusetts mineral industry in 1976¹

	Men	Man-hours	Fatal injuries	Fatal frequency rate	Non-fatal disabling injuries	Non-fatal disabling frequency rate	Nondisabling injuries	Nondisabling frequency rate
Gold-silver:								
Underground	2	38	--	--	--	--	--	--
Sand and gravel:								
Surface	1,191	1,892,807	--	--	8	5.74	3	2.15
Office	224	269,894	--	--	--	--	--	--
Total	1,415	1,662,701	--	--	8	4.81	3	1.80
Stone:								
Surface	401	726,507	--	--	13	17.89	2	2.75
Mills	381	763,916	--	--	24	31.42	1	1.31
Office	182	274,349	--	--	--	--	--	--
Total	964	1,764,772	--	--	37	20.97	3	1.70
Clays:								
Surface	13	18,358	--	--	--	--	--	--
Mills	12	18,720	--	--	--	--	--	--
Office	3	4,640	--	--	--	--	--	--
Total	28	41,718	--	--	--	--	--	--
Peat:								
Surface	6	4,959	--	--	--	--	--	--
Mills	6	1,817	--	--	--	--	--	--
Office	1	400	--	--	--	--	--	--
Total	13	7,176	--	--	--	--	--	--
State totals:								
Underground	2	38	--	--	--	--	--	--
Surface	1,611	2,142,631	--	--	21	9.80	5	2.33
Mills	399	784,453	--	--	24	30.59	1	1.27
Office	410	549,283	--	--	--	--	--	--
Grand total	2,422	3,476,405	--	--	45	12.94	6	1.73

¹ Data supplied by Mining Safety and Health Administration, U.S. Department of Labor.

Massachusetts was introduced into the legislature as a result of interest in Narragansett Basin coal. The bill was premature and returned to committee. The interest in coal was prompted by the preliminary results reported on the Weston Observatory—Boston College research in the Narragansett Basin. It has been reported that coalbeds have been encountered in drill holes at Mansfield, Brayton Point, and elsewhere in Massachusetts and Rhode Island. There is also renewed interest in burning more coal for power generation, and at yearend the Federal Regional Council was sponsoring a project to determine the feasibility of burning coal in the Brayton Point power station of the New England Power Co.

The Office of the State Geologist was transferred from the Department of Public

Works to the Department of Environmental Quality Engineering.

Coastal zone management programs were being devised by all of the New England Coastal States as mandated by Federal coastal zone legislation. The plans impacted present and future mining with varying severity, but in all cases offered new restrictions or additional operational requirements on the minerals industry.

A visitor guide to mining and mineral operation in the northeast, including Massachusetts, was published by the Bureau of Mines.³ The booklet described active and abandoned mining sites and camps that could be visited or easily viewed from major highways.

³ U.S. Bureau of Mines. Mining and Mineral Operations in the New England and Mid-Atlantic States. A Visitor Guide. BuMines SP 10-76, 1976, pp. 21-27.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement is not produced in Massachusetts. In 1976, domestic producers shipped 810,545 tons of finished portland cement and 34,704 tons of prepared masonry cement into the State compared with the equivalent 1975 figures of 913,980 and 33,742 tons.

Clay and Shale.—Common clay and shale production in 1976 increased 2% in tonnage and 4% in value compared with 1975. The principal producers of brick and common clay products were K-F Brick Co., Inc. (Susquehanna Corp.) at Middleboro; and Stiles & Hart Brick Co. at Bridgewater. The Masslite Div. of Plainville Corp. produced expanded lightweight aggregate for use in concrete products from shales and boney anthracite of the carboniferous Narragansett Basin.

Gem Stones.—Small amounts of gem stones and specimens were collected by hobbyists. Amethyst from Bellingham was of particular interest in recent years. Efforts continued to have rhodonite declared the State gem.

Graphite.—Small quantities of synthetic graphite were reportedly produced in Massachusetts.

Gypsum.—United States Gypsum Co. calcined raw gypsum from Canada at Charlestown (Boston) in Suffolk County. Output of gypsum products increased from 1975.

Lime.—Pfizer, Inc., and Lee Lime Corp. produced 178,000 tons of lime in Berkshire County for food products, precipitated calcium carbonate, mason's lime, sewage treatment, and other uses. Production increased 17% compared with the previous year. The lime was used in Massachusetts,

New York, Connecticut, and other States. Total consumption of lime in Massachusetts was 53,822 tons compared with 44,716 tons in 1975.

Pfizer, Inc., started a \$3 million expansion at its Adams' mill and mine that will double capacity to produce precipitated calcium carbonate. The project, which included a new dust collector, was scheduled for completion in early 1977.

Perlite (Expanded).—Crude perlite mined outside the State was expanded at two plants in Suffolk County that sold the product mainly for lightweight aggregate, low-temperature insulation, masonry and cavity fill insulation, and horticultural aggregate.

Sand and Gravel.—Sand and gravel production in 1976 increased 21% in quantity and 20% in value compared with 1975. The \$29.7 million of sand and gravel produced was 43% of the total value of Massachusetts mineral output, making sand and gravel second only to stone as a mineral commodity produced in the Commonwealth. There were 198 sand and gravel pits in operation, 5 of which produced industrial sands or gravel.

Sand and gravel production was reported from all counties in the State except Suffolk. Building and paving markets consumed the major portion of the production. Industrial sand was used for molding, blast, and filtration, and industrial gravel was sold for metallurgical use.

An environmental research report was prepared that was intended to explain the sand and gravel industry and its problems to citizens and legislators.⁴

⁴ Lamb, R. and Associates. *Understanding Sand and Gravel*. 1976, 45 pp.

Table 5.—Massachusetts: Construction and industrial sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	9,214	\$13,361	\$1.45
Gravel -----	6,785	15,685	2.31
Total ¹ -----	16,000	29,046	1.82
Industrial:			
Sand -----	83	615	7.41
Gravel -----	2	4	2.00
Total -----	85	619	7.28
Grand total ¹ -----	16,084	29,666	1.84

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

Table 6.—Massachusetts: Construction sand and gravel sold or used by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	5,378	\$12,357	\$2.30
Concrete products (cement blocks, bricks, pipes, etc.) -----	896	1,983	2.21
Asphaltic concrete aggregates and other bituminous mixtures -----	1,753	3,597	2.05
Roadbase and coverings -----	3,410	4,880	1.43
Fill -----	3,732	4,524	1.21
Other uses -----	830	1,705	2.05
Total -----	¹ 16,000	29,046	1.82

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

Stone.—Stone production increased 11% in tonnage and 17% in value in 1976. Crushed and broken stone accounted for 99% of the total stone quantity in 1976 and 84% of total value. Stone, valued at \$33.5 million, was the largest mineral product in Massachusetts in 1976, contributing 48% of the value of the State's total mineral production.

Dimension stone production increased 26% to 81,865 tons valued at \$5.4 million, while crushed and broken stone increased 11% to 7.9 million tons valued at \$28.1 million.

Stone, produced at 42 quarries in 11 counties, included basalt, granite, limestone (marble), dolomite (marble), sandstone, and miscellaneous stone. Basalt was the most important stone in both quantity and value.

Crushed and broken stone producers were the quantity leaders in the stone field.

They included John S. Lane & Son, Inc.; Simeone Stone Corp.; and Warren Bros. Co., Div. of Ashland Oil & Refining Co., Inc. The value leaders, however, were H. E. Fletcher Co., a producer of granite dimension stone; and Pfizer, Inc., a producer of ground lime stone (marble) products. Both products have much higher unit values than stone for construction aggregate.

Among the States, Massachusetts ranked third in output of dimension granite, fourth in crushed traprock, and fifth in total output of dimension stone.

The Granite Railway in West Quincy was designated a National Historic Engineering landmark by the American Society of Civil Engineers. Completed in 1826, the railway demonstrated the advantages of commercial rail transport. The railroad was built to haul 16-ton granite blocks from the Quincy quarries to a Ne-

ponset River barge terminal, and it is credited with the introduction of such technical improvements as switches, turntables, and double-truck railway cars.

The single most important quarry of early man in North America was found by an amateur archeologist on the Milton-Quincy town line. The quarry, in the Braintree slate, was a source of tools and weapons as much as 7,000 years ago.

Roofing Aggregate.—Output of rhyolite to make roofing granules decreased slightly.

The rhyolite is quarried in Norfolk County and for statistical purposes it is classified as miscellaneous stone.

Vermiculite.—The quantity and value of the vermiculite processed in Massachusetts during 1976 decreased slightly. W. R. Grace & Co. in Hampshire County exfoliated vermiculite mined outside the State. The material was used mainly as insulation; other uses in order of production were concrete aggregate, soil conditioning, and plaster.

Table 7.—Massachusetts: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	2,580	7,621	3,024	9,455
Roadstone -----	1,742	4,746	1,136	2,738
Dense-graded roadbase stone -----	631	1,567	720	1,957
Railroad ballast -----	338	921	646	1,348
Concrete aggregate -----	443	1,061	541	1,448
Filter stone -----	169	530	283	855
Riprap and jetty stone -----	115	245	227	695
Roofing granules -----	138	421	167	472
Surface treatment aggregate -----	133	291	167	429
Agricultural limestone -----	151	1,083	138	1,021
Macadam aggregate -----	71	229	127	399
Other uses ² -----	594	4,870	678	7,331
Total ³ -----	7,105	23,584	7,855	28,150

¹ Includes traprock, granite, limestone, and miscellaneous stone.

² Includes stone used in lime manufacture, fill, whitening, mineral food, drain fields (1975), asphalt filler, flux stone, and other uses.

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

MINERAL FUELS

Statistics on Massachusetts fuel consumption are published annually by the New England Fuel Institute in the March issue of "Yankee Oilman." Data for 1974 were published in 1976.

The Bureau of Mines published two reports detailing fuels and energy data by individual Eastern States including Massachusetts.⁵

The New England Federal Regional Council in Boston began publication of a series of reports on New England energy problems. One of the first was titled "New England Potential for Increased Use of Coal." It, and others in the series, may be obtained from the Federal Energy Administration in Boston.

Another Bureau of Mines Information Circular⁶ shows the results of a June 1976 survey of planned or proposed coal mines,

coal and noncoal conversion plants, oil refineries, uranium enrichment facilities, and related infrastructures.

The Director of the Massachusetts Energy Policy Office promised new energy policies and developments in an article which appeared in the "New England Construction" magazine.⁷

⁵ Crump, L. H. Historical Fuels and Energy Consumption Data, 1960-72, United States by States and Census Districts East of the Mississippi. BuMines IC 8704, 1976, 456 pp.

_____. Fuels and Energy Data: United States by States and Census Divisions, 1973. BuMines IC 8722, 1976, 112 pp.

⁶ U.S. Bureau of Mines. Projects to Expand Fuel Sources in Eastern States. Survey of Planned or Proposed Coal Mines, Coal and Noncoal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilities, and Related Infrastructure, in States East of the Mississippi River (as of June 1976). BuMines IC 8725, 1976, 114 pp.

⁷ Lee, H. Coal Exploration, Off-Shore Oil Drilling May Lead to Construction Boom in New England. N. Engl. Const. Mag., June 28, 1976.

Coal.—As a result of interest generated by Bureau of Mines analyses of specimens collected at Mansfield, Mass., and Portsmouth, R.I., investigation of the coal potential of the Narragansett Basin was undertaken in February 1976. The work was being conducted by the Weston Observatory of Boston College using funds for geological and environmental studies supplied by the National Science Foundation and funds for diamond drilling supplied by the New England Regional Commission and several private firms and utilities. The Bureau of Mines provided free analytical and coal-cleaning services on all samples that Weston Observatory submitted. By yearend, important discoveries of anthracite and semianthracite coal had been made at several localities. Progress during 1976 was detailed in an interim report titled "The Pennsylvanian Coal-Bearing Strata of the Narragansett Basin," NSF/RANN Document NSF/RA 76-0337. The 54-page report was submitted to NSF by Weston Observatory as required under Grant No. AER 76-02147.

Masslite Div. of the Plainville Corp. continued to burn unknown quantities of Massachusetts anthracite at Plainville where three poor-quality coalbeds are mined intermixed with shale and fired together with anthracite from Pennsylvania to produce lightweight aggregate.

House Bill 917 was signed into law by the Governor. The bill reclassified coal fly ash from a waste product that had to be

sanitary land-filled to a byproduct raw material.

Peat.—Reed-sedge peat was mined by Sterling Peat Co. in Worcester County. The peat was used mainly by nurserymen, landscapers, and greenhouse owners.

Petroleum.—Planned leasing of Georges Bank tracts proceeded systematically with drilling of a stratigraphic "off-structure" test hole by a consortium of oil companies. An additional hole was planned further offshore to test the outer portion of the Bank. Tracts for sale were nominated and the location of those to be offered for sale in 1977 was announced by the U.S. Department of the Interior.

In December, the Liberian tanker *Argo Merchant* broke up on Nantucket Shoals and its cargo of 7.5 million gallons of residual fuel oil was spilled into the North Atlantic. Fortunately, wind and current took the oil into the mid-Atlantic rather than driving it onto resort beaches or over the Georges Bank fishing grounds.

METALS

Gold.—The first gold "production" in years was reported from Keets Brook in Bernardston. Richard Brown recovered 1 ounce of flakes during 5 months of week-end panning.

Manganese.—Chemetron, Inc., decided not to drill the Anson Betts manganese mine and dropped its option.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
K-F Brick Co., Inc. (Susquehanna Corp.).	River St. Middleboro, Mass. 02346	Pit -----	Plymouth.
Plainville Corp., Masslite Div. ¹	Box 327 Walpole, Mass. 02081	Pit -----	Norfolk.
Stiles & Hart Brick Co ---	Box 367 Bridgewater, Mass. 02324	Pit -----	Plymouth.
Gypsum, calcined:			
United States Gypsum Co. ²	101 South Wacker Dr. Chicago, Ill. 60606	Plant -----	Suffolk.
Lime:			
Lee Lime Corp. ³ -----	Marble St. Lee, Mass. 01238	----do -----	Berkshire.
Pfizer, Inc. ³ -----	260 Columbia St. Adams, Mass. 01220	----do -----	Do.
Peat:			
Sterling Peat Co -----	Sterling Junction, Mass. 01565	Bog -----	Worcester.
Perlite, expanded:			
Whittemore Products, Inc..	35 Harrison St. Roslindale, Mass. 02131	Plant -----	Suffolk.
Roofing granules:			
Bird & Son, Inc -----	49 Washington St. East Walpole, Mass. 02032	----do -----	Norfolk.
Sand and gravel:			
Construction:			
J. J. Cronin Co -----	Box 176 North Reading, Mass. 01864	Pit -----	Middlesex.
E. L. Dauphinais, Inc..	160 Worcester Rd. North Grafton, Mass. 01536	Pit -----	Worcester.
Glenview Sand and Gravel Corp.	152 Steadman St. Chelmsford, Mass. 01824	Pit -----	Do.
Hyannis Sand and Gravel Co.	Box 96 Hyannis, Mass. 02601	Pit -----	Barnstable.
J. L. Construction Co..	5 Cyprus Dr. Burlington, Mass. 01803	Pit -----	Middlesex.
Marshfield Sand and Gravel, Inc.	Clay Pit Rd. Marshfield, Mass. 02050	Pit -----	Norfolk.
Merrimack Paving Corp.	Yemma Rd. Groveland, Mass. 01830	Pit -----	Essex.
Namasket Construction Co.	Box 296 Middleboro, Mass. 02341	Pit -----	Plymouth.
A. A. Will Sand & Gravel Corp.	Turnpike St. Canton, Mass. 02021	Pit -----	Norfolk.
Worcester Sand & Gravel Co.	182 Holden St. Shrewsbury, Mass. 01545	Pit -----	Worcester.
Industrial:			
Southeastern Sand and Gravel, Inc.	Kingston, Mass. 02364 -----	Pit -----	Plymouth.
Whitehead Bros. Co ---	60 Hanover Rd. Florham Park, N.J. 07932	Pit -----	Do.
Stone:			
G. Brox, Inc -----	1471 Methuen St. Dracut, Mass. 01826	Quarry -----	Middlesex.
Essex Bituminous Concrete, Inc.	55 Russell St. Peabody, Mass. 01960	----do -----	Essex and Middlesex.
H. E. Fletcher Co -----	West Chelmsford, Mass. 01863	----do -----	Middlesex and Worcester.
P. J. Keating Co -----	Box 367 Fitchburg, Mass. 01420	----do -----	Worcester.
John S. Lane & Son, Inc --	Box 125 Westfield, Mass. 01085	----do -----	Hampden and Hampshire.
Lynn Sand & Stone Co ---	30 Danvers Rd. Swampscott, Mass. 01907	----do -----	Essex.
LeMasurier Granite Quarry, Inc.	Box 71, Ledge Rd. North Chelmsford, Mass. 01863	----do -----	Middlesex.
Manchester Stone & Gravel Co.	Box 402 Manchester, Mass. 01944	----do -----	Do.
Massachusetts Broken Stone Co.	133 Boston Post Rd. Weston, Mass. 02193	----do -----	Middlesex.
Old Colony Crushed Stone Co.	Box 230 Quincy, Mass. 02169	----do -----	Norfolk.
Simeone Stone Corp -----	1185 Turnpike St. Stoughton, Mass. 02072	----do -----	Do.

See footnotes at end of table.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Trimount Bituminous Products Co.	1840 Revere Beach Parkway Everett, Mass. 02149	Quarry -----	Essex.
Warren Bros. Co., a division of Ashland Oil & Refining Co., Inc.	430 Howard St. Brockton, Mass. 02402	----do -----	Bristol.
Vermiculite, exfoliated: W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, Mass. 02140	Plant -----	Hampshire.

¹ Also sand and gravel.² Also expanded perlite.³ Also stone.

The Mineral Industry of Michigan

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey Division of the Michigan Department of Natural Resources, under a memorandum of understanding for collecting information on all minerals except coal and liquid fuels.

By Edward C. Peterson¹ and Esther A. Middlewood²

Michigan's mineral industry continued to make significant gains in 1976, mainly because of record petroleum and natural gas production and higher prices for the minerals produced. For the fifth consecutive year, the value of Michigan's raw mineral output increased, establishing a record high of \$1.54 billion, a 19.5% rise over that of 1975.

Nonmetallic mineral production rose after 5 consecutive years of decline, reflecting increased demands in the construction industry. These commodities contribute the major part of the State's total mineral value, accounting for \$574 million, or 37.2% of the total. Nationally, Michigan continued to be a leading producer of bromine, calcium chloride, cement, gypsum, salt, and sand and gravel. Michigan is the sole producer of iodine in the United States.

Metals accounted for \$503 million, or 32.6% of the total mineral value. Iron ore continued to be the single leading mineral commodity in terms of value. Shipments and values were significantly higher in 1976. Production and value of copper declined 41% and 36%, reflecting a slump in the copper industry which began in mid-1974 and prevailed throughout 1976.

Total output of mineral fuels (natural gas, natural gas liquids, peat, and petroleum) were valued at \$466 million, an increase of 37% over 1975. Oil and gas production continued at record levels, accounting for 30% of the total mineral value in 1976. The State continued to be

the largest domestic producer of peat. After 2 years of limited coal production, no output was reported in 1976.

Major developments in the mineral industry of Michigan during 1976 included: Plans announced by Cleveland-Cliffs Iron Co. (CCI) for a \$750 million expansion of iron ore production capacity at the Tilden and Empire properties near Ishpeming; awarding a \$13.6 million contract to The Dow Chemical Co. of Midland by the U.S. Energy Research and Development Administration (ERDA) to test the feasibility of extracting oil and gas from the Antrim Shale deposits that underlie most of lower Michigan; proposed acquisition of Copper Range Co., the parent company of White Pine Copper Co. and the State's major copper producer, by Louisiana Land & Exploration Co. (LL&E); and exploration for uranium deposits on 200,000 acres of Upper Peninsula land leased jointly by the Tennessee Valley Authority (TVA) and a subsidiary of International Nickel Co.

Each year the Geology Div., Department of Natural Resources (DNR), publishes a directory of mineral producers operating in the State. The current issue, the 10th Annual Directory issued, lists over 500 mineral operations that were active during 1976, exclusive of oil and gas. The names and addresses of producers and

¹ State Liaison Officer, Bureau of Mines, Lansing, Mich.

² Liaison program assistant, Bureau of Mines Liaison Office, Lansing, Mich.

Table 1.—Mineral production in Michigan¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry -----thousand short tons--	183	\$6,429	218	\$8,370
Portland -----do-----	4,573	131,324	4,931	145,381
Clays -----do-----	1,818	3,580	1,934	4,741
Copper (recoverable content of ores, etc.) short tons--	73,690	94,618	43,707	60,840
Gem stones -----	NA	8	NA	10
Gypsum -----thousand short tons--	1,224	5,936	1,337	9,842
Iron ore (usable), thousand long tons, gross weight -----	14,089	339,113	16,245	441,206
Lime -----thousand short tons--	1,434	36,540	1,456	39,686
Natural gas -----million cubic feet--	102,113	64,740	119,262	106,739
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels--	656	3,294	3,504	19,725
LP gases -----do-----	1,348	5,945	1,215	6,306
Peat -----thousand short tons--	245	3,206	300	3,714
Petroleum (crude) thousand 42-gallon barrels--	24,420	262,352	30,421	329,637
Salt -----thousand short tons--	4,020	68,353	4,219	78,740
Sand and gravel -----do-----	47,051	73,397	47,403	78,455
Silver (recoverable content of ores, etc.) thousand troy ounces--	632	2,795	311	1,352
Stone -----thousand short tons--	39,946	73,800	41,485	82,331
Value of items that cannot be disclosed:				
Bromine, calcium chloride, iodine, and magnesium compounds -----	XX	116,223	XX	125,441
Total -----	XX	1,291,653	XX	1,543,516
Total 1967 constant dollars -----	XX	511,107	XX	\$ 554,894

^p Preliminary. NA Not available. XX Not applicable.

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

Table 2.—Value of mineral production in Michigan, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Alcona -----	\$124	\$187	Sand and gravel.
Alger -----	77	207	Do.
Allegan -----	2,474	2,174	Petroleum, sand and gravel, stone, natural gas, peat.
Alpena -----	61,660	65,116	Cement, stone, clays, sand and gravel.
Antrim -----	W	W	Petroleum, natural gas, clays, sand and gravel.
Arenac -----	W	W	Petroleum, stone, sand and gravel.
Baraga -----	110	183	Sand and gravel.
Barry -----	W	W	Sand and gravel, petroleum, stone.
Bay -----	11,801	14,115	Cement, petroleum, sand and gravel, lime.
Benzie -----	83	W	Sand and gravel, petroleum.
Berrien -----	4,691	5,095	Sand and gravel, stone.
Branch -----	488	217	Do.
Calhoun -----	17,909	21,716	Petroleum, natural gas, sand and gravel, stone.
Cass -----	W	W	Sand and gravel, petroleum, stone.
Charlevoix -----	W	W	Cement, stone, sand and gravel.
Cheboygan -----	188	W	Stone, sand and gravel, petroleum.
Chippewa -----	W	W	Stone, sand and gravel.
Clare -----	3,980	W	Petroleum, sand and gravel, natural gas.
Clinton -----	W	W	Sand and gravel, clays.
Crawford -----	9,741	W	Petroleum, natural gas, sand and gravel.
Delta -----	W	W	Sand and gravel, stone.
Dickinson -----	W	W	Iron ore, sand and gravel, stone.
Eaton -----	4,969	8,239	Natural gas, petroleum, stone, sand and gravel, clays, peat.
Emmet -----	16,025	15,520	Cement, stone, clays, sand and gravel.
Genesee -----	W	W	Sand and gravel, petroleum.
Gladwin -----	W	W	Petroleum, sand and gravel.
Gogebic -----	249	158	Sand and gravel.
Grand Traverse -----	36,065	67,787	Petroleum, natural gas, sand and gravel.
Gratiot -----	11,030	11,097	Magnesium compounds, calcium chloride, salt, sand and gravel, petroleum, natural gas.
Hillsdale -----	20,410	19,448	Petroleum, natural gas, natural gas liquids, sand and gravel.
Houghton -----	1,375	2,959	Copper, sand and gravel, silver, stone.
Huron -----	W	W	Stone, lime, sand and gravel.
Ingham -----	30,872	31,913	Petroleum, natural gas, natural gas liquids, sand and gravel, peat.
Ionia -----	627	407	Sand and gravel.
Iosco -----	W	W	Gypsum, sand and gravel.
Iron -----	W	W	Iron ore, sand and gravel.
Isabella -----	W	W	Petroleum, sand and gravel.
Jackson -----	6,984	W	Petroleum, natural gas, sand and gravel, stone.
Kalamazoo -----	W	W	Sand and gravel, stone.
Kalkaska -----	64,541	80,471	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kent -----	5,028	5,117	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw -----	31	36	Sand and gravel.
Lake -----	W	W	Petroleum, sand and gravel.
Lapeer -----	2,832	3,654	Peat, petroleum, sand and gravel, calcium chloride, natural gas.
Leelanau -----	W	W	Sand and gravel.
Lenawee -----	W	1,021	Do.
Livingston -----	W	W	Sand and gravel, natural gas, petroleum.
Luce -----	W	W	Sand and gravel.
Mackinac -----	W	13,354	Stone, sand and gravel.
Macomb -----	W	W	Sand and gravel, natural gas, petroleum.
Manistee -----	61,375	126,365	Petroleum, magnesium compounds, salt, natural gas, bromine, sand and gravel.
Marquette -----	W	W	Iron ore, sand and gravel, stone.
Mason -----	57,984	68,882	Magnesium compounds, calcium chloride, lime, bromine, natural gas, petroleum, sand and gravel.
Mecosta -----	845	728	Petroleum, sand and gravel, natural gas, peat.
Menominee -----	174	76	Sand and gravel.
Midland -----	38,178	31,613	Bromine, calcium chloride, magnesium compounds, petroleum, salt, iodine.
Missaukee -----	7,558	7,496	Petroleum, natural gas, sand and gravel.
Monroe -----	23,538	33,099	Cement, stone, clays, sand and gravel, peat, petroleum.
Montcalm -----	W	W	Petroleum, sand and gravel.
Montmorency -----	4	W	Sand and gravel.
Muskegon -----	W	W	Sand and gravel, salt, petroleum.
Newaygo -----	W	W	Petroleum, sand and gravel.
Oakland -----	16,434	18,505	Sand and gravel, natural gas, petroleum, peat.
Oceana -----	W	W	Sand and gravel, petroleum.
Ogemaw -----	W	6,731	Petroleum, sand and gravel, natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Michigan, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Ontonagon -----	W	\$59,550	Copper, silver, sand and gravel.
Osceola -----	W	3,937	Petroleum, sand and gravel, natural gas liquids, natural gas.
Oscoda -----	W	W	Sand and gravel, petroleum.
Otsego -----	\$68,324	78,812	Petroleum, natural gas, sand and gravel.
Ottawa -----	5,264	W	Sand and gravel, petroleum.
Presque Isle -----	30,144	W	Stone, sand and gravel.
Roscommon -----	4,115	4,443	Petroleum, natural gas, sand and gravel.
Saginaw -----	2,440	W	Sand and gravel, lime, petroleum.
St. Clair -----	40,988	47,507	Salt, petroleum, natural gas, sand and gravel.
St. Joseph -----	W	W	Sand and gravel, stone, peat.
Sanilac -----	W	W	Peat, sand and gravel, lime.
Schoolcraft -----	W	1,423	Stone, sand and gravel.
Shiawassee -----	951	W	Peat, sand and gravel, clays, petroleum.
Tuscola -----	W	2,268	Sand and gravel, petroleum, lime, natural gas.
Van Buren -----	W	W	Sand and gravel, petroleum.
Washtenaw -----	W	W	Do.
Wayne -----	77,175	88,716	Lime, cement, salt, sand and gravel, stone, clays, petroleum.
Wexford -----	3,167	W	Petroleum, natural gas, sand and gravel.
Undistributed ² -----	588,727	593,169	
Total ³ -----	1,291,653	1,543,516	

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

¹ Value of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

² Includes values for gem stones and 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 Michigan business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	3,922.0	3,997.0	+1.9
Unemployment ----- do-----	490.0	374.0	-23.7
Employment (nonagricultural):			
Mining ----- do-----	13.8	12.7	-8.0
Manufacturing ----- do-----	983.7	1,056.7	+7.4
Contract construction ----- do-----	106.3	105.3	-.9
Transportation and public utilities ----- do-----	143.5	144.6	+.8
Wholesale and retail trade ----- do-----	656.4	674.7	+2.8
Finance, insurance, real estate ----- do-----	134.0	136.9	+2.2
Services ----- do-----	515.3	539.3	+4.7
Government ----- do-----	583.1	594.0	+1.9
Total nonagricultural employment ----- do-----	3,136.1	¹ 3,264.3	+4.1
Personal income:			
Total ----- millions--	\$54,463	\$61,485	+12.9
Per capita ----- do-----	\$5,978	\$6,754	+13.0
Construction activity:			
Number of private and public residential units authorized ----- do-----	36,980	45,895	+24.1
Value of nonresidential construction ----- millions--	\$605.8	\$599.3	-1.1
Value of State road contract awards ----- do-----	\$220.3	\$280.0	+27.1
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	2,475	2,735	+10.5
Mineral production value:			
Total crude mineral value ----- millions--	\$1,291.7	\$1,543.5	+19.5
Value per capita, resident population ----- do-----	\$142	\$170	+19.7
Value per square mile ----- do-----	\$22,187	\$26,514	+19.5

^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.

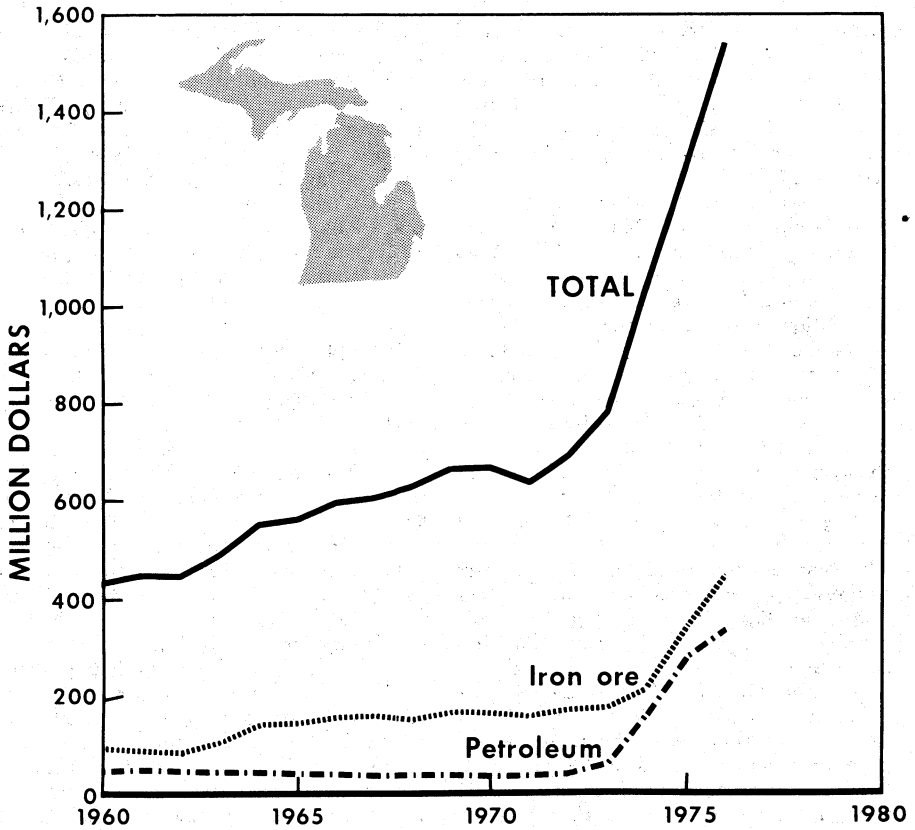


Figure 1.—Value of iron ore, petroleum, and total value of mineral production in Michigan.

processors are arranged alphabetically under the appropriate raw material or manufactured commodity. In addition, a listing of all producers by county is included, providing the location of the various operations whenever possible. Other data in the publication pertinent to Michigan's mineral industry include recent legislation, geologic information, and a listing of current State publications. The 1976 edition is unique in that it also contains a listing of the current DNR sand and gravel pits arranged by county. These pits are on lands under the jurisdiction of DNR and are mined according to a mine plan which includes the overall reclamation of the pit site upon completion of the removal operations.

Protection of workers involved in mining activities improved during 1976, with a reduction in injury rates reported. Inspections performed by the two Michigan field offices of the Mining Enforcement and Safety Administration (MESA) totaled 844. These inspections included health (dust, air, noise, and radiation) and all safety aspects of the mining industry. Under an agreement with the Michigan Department of Labor, all mine investigations are conducted by MESA inspectors, making them responsible for the health and safety of approximately 13,000 mine workers.

Legislation and Government Programs.—Active Federal Bureau of Mines contracts and grants to State universities

and private industry in Michigan totalled approximately \$2.5 million in 1976. Many of these projects are continued from previous years, but about \$63,000 of new contracts were issued during 1976, that involved mineral availability and mining technology.

In May 1976, the National Science Foundation awarded a \$3,000 subcontract to Michigan Technological University to study institutional and economic factors of geothermal energy resources for the production of electrical energy.

On October 23, 1976, Michigan Technological University officials dedicated an experimental mine developed as a research and educational facility. University officials reached an agreement with owners of the Quincy Mining Co. over the long-term lease of a 1,800-foot section of an inactive underground copper mine in Ripley. The facility will be used as a laboratory for the education of students in mining engineering, research and development of improved mining methods, and as a site for the testing of prototype underground mining equipment.

Also in October, ERDA awarded a \$13.6 million contract to The Dow Chemical Co. to develop technology that would permit tapping the Antrim Shale as a source of synthetic gas. For the past 20 years, Dow has been conducting a proprietary experimental program with Antrim Shale supported by an oil shale development consortium in Michigan.

The Governor announced the approval of 13 Michigan economic development grants totalling \$1.08 million from the Upper Great Lakes Regional Commission in 1976. Among the new grants was \$23,264 to Northwestern Michigan College at Traverse City for expanding a recently initiated petroleum technology training program in cooperation with Michigan's oil and gas industry.

Two major controversial issues generated interest in the Michigan Legislature during 1976; oil and gas drilling in the Pigeon River Country State Forest, and the disposal of nuclear wastes in Michigan. Numerous bills designed to protect the environment from these activities were either defeated or referred to legislative committees during the session. Included were H.B. 6141, which provided for an advisory opinion on drilling wells in

Pigeon River; H.B. 6549, providing for State acquisition of all outstanding interests in Pigeon River; H.B. 6610, requiring certification of reliability before construction of nuclear waste disposal facilities; and S.B. 1551, regulating the disposal of high-level radioactive wastes.

Although not directly related to mining operations, two other bills might eventually have an effect on mineral production. House Bill 5989 prohibited the use of sodium chloride (salt) on roads, streets, or highways; while H.B. 6555 banned the sale of phosphate detergents. Neither bill was reported out of committee at the close of 1976. Michigan is the Nation's second leading producer of salt.

Legislation to repeal Public Act 264 of 1967, entitled "Mine Safety Act of 1967," was passed by the House of Representatives on November 22, 1976, and referred to the Senate for approval. At the close of 1976, the bill (H.B. 5580) remained in the Senate Committee on Labor. Therefore, the law remained on record but is not funded by the Legislature.

A bill, originally introduced in January 1975 as H.B. 4038 was a source of controversy for several months. The bill was designed to establish controls over the mining of Michigan's sand dunes. Representatives of the sand mining industry raised objections to the surveillance fee system proposed by DNR. Spokespersons for the sand mining and automotive industries also claimed the bill would adversely affect the automotive industry by reducing the supply of sand. Nearly all the foundries producing automobile parts use Lake Michigan sand as core molds. Local citizens supported the bill to protect a fragile environment that cannot be duplicated elsewhere. The bill spent almost 8 months in the Senate Conservation Committee, after passing the House by a margin of 97 to 6 in November 1975. Public Act 222 was signed into law on July 30, 1976, and takes effect on April 1, 1977.

A bill proposing the creation of a Michigan Port Authority was introduced in the State Legislature at the close of 1976. The bill would enable cities and counties to develop local port authorities and to receive managerial and financial assistance from State and Federal Governments. The last major port legislation in Michigan was adopted in 1925. The 1925 Act limits port

development to the financing capabilities of the port city.

Exploration.—Potentially important deposits of rocks rich in the phosphate mineral apatite, a major raw material in fertilizer production, may occur in northern Michigan. Testing of rock samples found during fieldwork conducted by the U.S. Geological Survey indicated the existence of such materials. Government scientists announced the discoveries, located about 40 miles northwest of Marquette. Geologic studies indicate the deposits are about 2 billion years old, and they appear to be among the oldest and richest sedimentary accumulations of phosphate known in the United States. A deposit of phosphate in the Upper Peninsula could be valuable as a small-scale industry producing fertilizers for midwest farmers.

Other exploration in Michigan during 1976 included the following activities:

CCI and Chevron Oil Co. formed a joint venture to investigate copper potential of the Kona Dolomite Formation in Marquette County, as well as to explore for uranium and other base metals.

Uranium exploration by the TVA continued on a 200,000-acre tract in the western part of the Upper Peninsula.

Continued oil and gas exploration was concentrated in the northern regions of the Lower Peninsula.

Transportation.—The Soo Line Railroad, operators of a 42-mile stretch of track linking Baraga, Calumet, Hancock, and Lake Linden, have petitioned the Interstate Commerce Commission for the right to abandon the line. The track serves an area hard-hit by copper mine closings and slowdowns in recent years. It has served the western Upper Peninsula's copper country since 1872, but Soo Line officials report it turned into a losing proposition as the copper mines closed.

Seven Great Lakes shipping companies joined the Maritime Administration in funding a \$230,000 research project to open the northern waterways to year-round shipping. The project seeks to develop an improved bow design that will enable bulk-carrying vessels to transit the heavy ice that halts shipping operations in the winter. The ice-transiting bow research is part of a winter navigation demonstration program authorized by Congress in

1970 and aimed at extending the navigation season on the entire Great Lakes-St. Lawrence Seaway System. Shipping companies involved in the project include Pickands Mather & Co., Litton Great Lakes Corp., American Steamship Co., Hanna Mining Co., Cleveland-Cliffs Steamship Co., Oglebay Norton Co., and United States Steel Corp.

The State Highway Commission approved plans for a study of Michigan's 22 commercial harbors in May 1976. The \$400,000 study will evaluate the role of harbors in the State's economy, predict their future, and suggest improvements in port facilities. The 18-month study is scheduled to begin in January 1977, and it will be conducted by the Department of State Highways and Transportation, Port Development Section. Michigan uses the Great Lakes for the transport of coal consumed by electric power companies, as well as the shipment of many mineral commodities (iron ore, sand and gravel, stone, etc.).

The air-bubbling system designed by CCI and installed at the Escanaba ore-loading facility in 1974 made a major contribution to keeping the loading pier and turning basin open to shipping in late 1976. Exceptionally severe ice conditions throughout the Great Lakes Seaway System created problems for winter navigation. Research and environmental studies associated with the Great Lakes Winter Navigation Program continued to be conducted by CCI and various Government agencies during the year.

The Lake Superior and Ishpeming Railroad began operation of a new facility at the Port of Marquette in 1976 to improve the handling of coal destined for the Presque Isle powerplant of the Upper Peninsula Generating Co. The new facility consists of an unloading hopper situated offshore in Presque Isle harbor just north of the city, a conveyor system, and a stockpile adjacent to the powerplant. Formerly, the coal was delivered to the Marquette Dock Co., near the city's downtown area, owned jointly by Pickands Mather & Co. and Spear & Sons, Inc. On an annual basis, the coal handled by the dock amounted to about 500,000 tons in 50-vessel cargoes. As a result of a major expansion in the iron ore operations of CCI, an increase was required in the capacity

of Upper Peninsula Generating, owned 80.96% by Cliffs Electric Co., a wholly owned subsidiary of CCI, and 19.05% by Upper Peninsula Power Co. of Houghton. To provide the expanded requirements of the Tilden and Empire mines, three additional units are under construction at Upper Peninsula Generating. These units, now under construction for service in 1979, added to the seven units currently operating will require 2 million short tons of coal annually. The existing seven units will continue to operate on eastern coal, with delivery coming from Sandusky and Toledo, Ohio. The other three units will use western low-sulfur coal.

On June 17, 1976, the official dedication of the first transshipment and storage terminal on the Great Lakes for low-sulfur coal originating in the Western United States took place in Superior, Wis. The new \$35 million facility, owned by Midwest Energy Resources Co., a wholly owned subsidiary of Detroit Edison Co., is designed to handle coal produced by Decker Coal Co. at its open pit mine in southeastern Montana and transported to the head of the Lakes by Burlington Northern Railroad. At the Superior terminal, the coal is loaded into self-unloading vessels of the American Steamship Co. fleet for delivery to Detroit Edison's powerplant in St. Clair. The Wisconsin terminal is situated at about midpoint in the 1,700-mile distance between the Decker mine and the St. Clair plant. The facility represents a gateway for the transportation of fuel from West to East, a movement counter to previous routes from East to West. The new Belle River powerplant, located near the present St. Clair facility,

is targeted for completion by Detroit Edison early in the 1980's. This plant is also scheduled to burn western coal to generate electricity for customers in southeastern Michigan.

Employment.—Michigan continued to suffer from high unemployment rates during 1976. According to statistics from the Michigan Employment Security Commission, unemployment for the State averaged 10% during the year, compared with 14% in 1975.

In January 1976, mining operations at the White Pine copper mine were cut back because of depressed copper prices. More than 2,000 employees were laid off, giving the White Pine area an unemployment rate of 21.9%. In addition, about 120 workers were indefinitely laid off in October when the Centennial mines in Calumet, operated by Homestake Copper Co., closed. According to Homestake officials, the mines will be kept up so that mining could resume if conditions improve in the industry. About 45 persons continued to be employed in Centennial's copper exploration program.

Assistance was available for some mine workers under the Trade Readjustment Assistance Act of 1974, that became effective April 3, 1975. White Pine Copper Co. and Jones & Laughlin Steel Corp., whose Warren steel plant closed during 1976, were certified for assistance. Reasons given for certification included sales and production of the firms have decreased substantially due to increased imports.³

³ Michigan State Economic Record. Economic Assistance Under the Trade Act of 1974. V. 18, No. 5, September-October 1976, pp. 1-2, 10-12.

Table 4.—Michigan: Employment and injury statistics in the mineral industry

	Number of men	Man-hours worked	Number of injuries			Frequency injury rates per million man-hours ¹		
			Fatal	Non-fatal disabling	Nonfatal disabling	Fatal injuries	Nonfatal disabling injuries	Non-disabling injuries
1975 ^r								
Metal:								
Iron	4,371	8,997,941	--	344	20	--	38.23	2.22
Copper	2,886	5,835,217	1	130	64	0.18	23.49	11.56
Total or rate-metal	7,257	14,833,158	1	474	84	.07	32.62	5.78
Nonmetal:								
Sand and gravel	1,900	2,447,818	--	43	57	--	17.57	23.99
Stone	1,942	3,811,618	--	27	24	--	7.08	6.30
Other nonmetals ²	697	1,827,729	--	5	56	--	3.77	42.18
Total or rate-nonmetal	4,539	7,887,165	--	75	137	--	10.30	18.80
Total, 1975	11,796	22,120,323	1	549	221	.05	24.92	9.90
1976								
Metal:								
Iron	4,464	9,105,481	2	333	4	.22	36.57	.44
Copper	1,633	3,074,323	--	63	31	--	20.49	10.08
Total or rate-metal	6,097	12,180,304	2	396	35	.16	32.51	2.87
Nonmetal:								
Sand and gravel	1,779	2,032,969	1	38	41	.49	18.69	20.17
Stone	3,106	6,744,619	--	39	13	--	16.56	2.07
Other nonmetals ²	691	1,405,276	--	28	50	--	19.93	36.31
Total or rate-nonmetal	5,576	9,682,764	1	165	104	.10	17.04	10.74
Total, 1976	11,673	21,863,068	3	561	139	.14	25.66	6.36

^r Revised.

¹ All injuries and all man-hours reported and in file will be tabulated, but when computing injury-frequency rates, only those injuries for which man-hours are reported and in file will be used.

² Includes clay, gypsum, peat, and salt.

Source: Mining Enforcement and Safety Administration, Health and Accident Analysis Center, Denver, Colo.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives, Manufactured.—In March 1976, Detroit Abrasives Co., Inc., began transformation of metallic abrasives at its plant in Owosso. The plant, purchased from MWA Co. (known as Mid-West Abrasive Co. prior to 1968), has housed machinery for producing ceramic abrasives for general industrial use since the early 1950's. MWA closed down production early in 1975 and sold the plant to Detroit Abrasives in September. The new Owosso Div. of Detroit Abrasives reduces man-made aluminum oxide crude ore into various grades of fine-grain abrasive material for use in the manufacture of sandpaper and grinding wheels.

The addition of Detroit Abrasives brings the total number of companies producing metallic abrasives in Michigan up to four in 1976. Production and value during the year increased by 16% and 25%. Michigan rose to first place in the national standings.

Bromine.—Michigan ranked second in production and value of bromine in the United States during 1976. Output of elemental bromine decreased 33% in quantity and 33.5% in value compared with 1975 levels. Bromine was recovered from well brines in Michigan by the following companies:

Company	Plant location	County
The Dow Chemical Co.	Ludington ---	Mason.
Michigan Chemical Co.	Midland ----	Midland.
Morton Chemical Co.	St. Louis ----	Gratiot.
	Manistee ----	Manistee.

In August, The Dow Chemical Co. announced it was phasing out production of ethylene dibromide. At the same time, the company released plans calling for quadrupled production of calcium bromide at its Midland plant by late 1977. Anticipated production includes 60 million pounds of calcium bromide solution and 12 million pounds of flake annually. Dow attributed rapidly increasing worldwide demand for calcium bromide solutions in the oil and gas drilling industry responsible for expansion plans.

Michigan Chemical Co. announced plans to discontinue operations at its St.

Louis plant within 2 years because of the high cost of meeting pollution criteria. The company planned to move its bromine operations to its El Dorado, Ark., plant by September 1978. Michigan Chemical is trying to sell the St. Louis plant, which employs about 350 persons.

Under an agreement reached with State officials in September, Michigan Chemical will pay a \$20,000 fine for polluting the Pine River with discharges from the St. Louis plant. The company is one of two firms which for more than 3 years have been involved in a controversy over an accidental mixing of PBB (polybrominated biphenyl) with animal feed in Michigan. Company officials have agreed to operate the plant until it is sold, as long as it can be operated on a profitable basis within the pollution control guidelines of the State of Michigan.

Calcium Chloride.—Michigan remained the leading U.S. producer of calcium chloride in 1976, with increases in both quantity and value of 9% and 13% respectively, over that of 1975. Calcium chloride is produced from brine in Gratiot, Lapeer, Mason, and Midland Counties by The Dow Chemical Co., Michigan Chemical Corp., and Wilkinson Chemical Corp.

Cement.—Production of portland cement in Michigan during 1976 registered a 10.4% gain. However a 3% decrease in masonry cement was recorded for the same period.

Imported clinker was processed by three cement companies: Martin Marietta Cement Co., Wyandotte Cement Inc., and Jefferson Marine Terminal (Div. of Edward C. Levy Co.).

Table 5.—Michigan: Portland cement salient statistics

	1975	1976
Number of active plants -----	8	8
Production -----	4,634,247	5,117,999
Shipments from mills:		
Quantity -----	4,572,739	4,931,392
Value -----	\$131,323,993	\$145,381,014
Stocks at mills, Dec. 31 -----	691,376	688,745

Table 6.—Michigan: Masonry cement salient statistics
(Short tons)

	1975	1976
Number of active plants.....	5	5
Production -----	220,129	213,491
Shipments from mills:		
Quantity -----	188,456	217,799
Value -----	\$6,429,396	\$8,869,742
Stocks at mills, Dec. 31.....	78,885	72,120

In a recent effort to improve overall efficiency, eliminate duplication of effort, and make possible better service to customers, National Gypsum Co., the parent of Huron Cement in Alpena, announced a consolidation program. In September 1976, the Allentown Cement Div. of Pennsylvania was combined with the Huron Cement Div. of Michigan to form a new cement division simply called Cement Div.—National Gypsum Co. Headquarters for the new division are located in Southfield.

Clays.—Clay and shale are mined by five companies in Michigan for use as an ingredient in the manufacture of cement. This use accounts for approximately 90% of the total clay production in 1976. Three other operators produce clay and shale for making drain tile, sewer pipe and flue linings, bricks, and pottery. Output of clay and shale in 1976 registered a 6% gain in quantity and a 32% rise in value when compared with 1975.

In September 1976, Janick Corp. of Toronto, Canada, parent of Canadian Brick, purchased the Michigan Brick operations in Corunna, Shiawassee County. The Canadian company announced plans to increase capacity at the facility by 21 million bricks per year, giving the plant an annual capacity of 69 million bricks.

Gypsum.—A federally guaranteed loan of \$1.05 million was made to Grand Rapids Gypsum Co. in April 1976 for the development of a new second level at the Butterworth Street mine in Kent County. Construction of an incline to a new level beneath the present mine will result in increased long-term production. The expansion will result in increased employment of 20% to 30% in the next few years.

National Gypsum Co. celebrated the Golden Anniversary of its National City plant during 1976. The plant was built in 1926 and began production in 1927. Pres-

ent employment at the three Iosco County facilities stands at 160 workers. Operations in Iosco County include the production facility at National City, now under partial modernization; the quarry in Grant Township; and Port Gypsum, ½ mile south of Tawas City limits on Lake Huron. Estimated reserves at the quarry, when calculated in 1954, were 75 million tons. The National City plant uses approximately 130,000 tons per year in the production of wallboard and cement rock used as a hardening retardant in setting cement.

National Gypsum is one of three gypsum companies in Iosco County. The others are United States Gypsum Co. at Alabaster, which employs an average of about 80 persons and Michigan Gypsum Co., which employs about 20 persons. United States Gypsum screens and ships raw materials at this location, but does no manufacturing in Iosco County.

Five companies mined 1.8 million tons of crude gypsum valued at \$9.8 million during 1976 in Iosco and Kent Counties. Output and value rose significantly, registering 50% and 66% gains, reflecting the improvement in the construction industry. Michigan currently ranks first among the States in the production of crude gypsum.

Four companies calcined gypsum in Iosco, Kent, and Wayne Counties during 1976. Output and value increased 18.4% and 43.7% respectively, compared with 1975. Actual output registered 455,643 tons valued at \$13.9 million in 1976. Calcined gypsum is used in the manufacture of plaster board, lath, and plaster.

Iodine.—The Dow Chemical Co. retained its title as sole U.S. producer of iodine during 1976, despite plans by another firm to begin production from brines in Oklahoma. Production showed a 33% decrease in 1976, with a 26% decrease in value compared with 1975.

Lime.—Michigan remained a leading producer of lime in 1976, placing fourth in the national ranking. Production amounted to 1.5 million tons, a 1.5% increase over 1975. Value of lime produced rose slightly to \$39.7 million an 8.6% increase. Lime in Michigan is used primarily in the manufacture of alkalies, steel, and petrochemicals. Leading counties of production were Wayne and Mason.

Magnesium Compounds.—Michigan again took the lead in the production of magnesium compounds during 1976 accounting for 63.5% of the U.S. total. Production increased 16% and value rose 27% compared with 1975.

Remodeling and construction work continued at Martin Marietta's Refractories Div. plant located at Midland. Although production was originally scheduled to begin in the second half of 1976, the company needed additional time to comply with air pollution regulations related to burning coal as fuel. The new target date is April 1977. Raw materials for the operation will be supplied by the Midland facility of The Dow Chemical Co. Dow will process dolomitic lime supplied by railcar from Martin Marietta's plant and convert the lime to magnesium hydroxide. The magnesium hydroxide will then be moved by pipeline from Dow to Martin Marietta. The new facility includes pipelines, pumps, and storage tanks. It will produce an intermediate grade of magnesite used for specialty refractory applications.

Martin Marietta continued the major expansion program begun almost 7 years ago at its Manistee plant. The plant, previously known as Standard Lime and Refractories Co., is one of the Nation's largest manufacturers of basic specialty products, chemical magnesium oxide, and periclase. Calcined dolomitic lime and brine are the essential raw materials used by Martin Marietta to manufacture the products, and chemical purity of 98.5% magnesium oxide is achieved. Dolomitic lime is shipped to Manistee by rail from another facility at Woodville, Ohio. Brine, which is pumped from wells adjacent to the Manistee plant, is reacted with the lime to produce magnesium hydroxide, which is then calcined to convert it to magnesium oxide. Martin Marietta has also invested \$12 million in its Eastlake periclase plant to increase capacity and to install expanded pollution control facilities. The complex at Manistee-Eastlake employs approximately 230 persons.

Perlite.—Crude perlite, mined in other States, was expanded by Harborlite Corp. and United States Gypsum Co. at plants located in Kalamazoo and Wayne Counties. Output of expanded perlite increased 15% in quantity and 46% in value over

1975. Expanded perlite is used for filter aid and plaster aggregate.

Salt.—Production of salt in Michigan during 1976 amounted to 4.2 million tons, an increase of 5% above 1975. Value of salt sold or used during the year rose slightly to \$11.4 million or 17%, reflecting the effects of continued inflation.

At Manistee, Hardy Salt Co. was well into its plant rehabilitation project during 1976. The project is expected to cost over \$1 million before completion. Manistee's other major salt producer, Morton Salt Co., was involved in a similar rehabilitation program. Both companies will receive a tax break under a State law encouraging industrial investment. Under the Michigan Plant Rehabilitation Law, industries are allowed to replace obsolete equipment, where an increase in employment is anticipated from the replacement, and to maintain existing tax valuations on the replaced portion of the plant for 12 years. Hardy and Morton indicated that a total increase of some 40 jobs is expected over the 12-year period. Salt is manufactured from brines at these locations.

Diamond Crystal Salt Co. continued work on its \$2.5 million expansion and modernization program at its St. Clair brine operation during 1976. The project is scheduled for completion in 1977.

Rock salt is mined in only one location in Michigan. International Salt Co., Inc., removes salt from an underground mine at Detroit, Wayne County. The salt is obtained from a depth of approximately 1,150 feet beneath the surface of the city.

Sand and Gravel.—Nearly every county in the State of Michigan contributed to the total construction sand and gravel production registered in 1976. Output for the year amounted to 42.1 million tons, while value registered at \$58.3 million.

A significant development for American Aggregates Corp. during the year was the announcement of plans to construct a new sand and gravel processing plant at Galesburg. (Kalamazoo County). Plans call for a production capacity of 700 tons per hour and completion is scheduled for November 1977.

Michigan again led the Nation in the production of industrial sand during 1976. The sand, most of which comes from dunes found along the Lake Michigan shoreline, is in demand by foundries and other au-

tomotive-related industries. Table 9 presents a comparison of industrial sand sold or used, by use category, for 1975-76.

Only 4% of the total sand and gravel

produced is used at the pit site. The remaining 96% is shipped to consumers by truck (84%), railroad (6%), waterway (3%) and other (3%).

Table 7.—Michigan: Construction aggregate¹ and industrial sand sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1976	
	Quantity	Value ²
Construction aggregate:		
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	12,371	21,501
Concrete products (cement blocks, bricks, pipe, etc.)	5,462	8,600
Asphaltic concrete aggregates and other bituminous mixtures	7,153	11,450
Roadbases and coverings	10,983	11,676
Fill	4,850	3,611
Other uses	1,299	1,419
Total	³ 42,067	58,257
Industrial sand	5,336	20,198
Total construction aggregate and industrial sand	47,403	78,455

¹ Includes processed and unprocessed sand and gravel.

² Values f.o.b. plant of blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

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

Table 8.—Michigan: Sand and gravel sold or used by producers, by county, in 1976
(Thousand short tons and thousand dollars)

County	Number of mines ¹	Quantity	Value
Alcona	4	167	187
Alger	4	147	207
Allegan	9	618	789
Alpena	2	W	W
Antrim	3	111	173
Arenac	1	83	10
Baraga	4	172	183
Barry	6	535	769
Bay	1	W	W
Benzie	1	32	32
Berrien	9	1,618	5,093
Branch	4	179	214
Calhoun	7	526	683
Cass	12	816	908
Charlevoix	4	135	141
Cheboygan	4	74	54
Chippewa	3	86	66
Clare	5	383	413
Clinton	12	1,041	1,460
Crawford	2	W	W
Delta	6	406	577
Dickinson	5	192	339
Eaton	10	659	806
Emmet	7	208	257
Genesee	3	148	298
Gladwin	2	W	W
Gogebic	6	161	158
Grand Traverse	5	175	444
Gratiot	9	333	354
Hillsdale	3	413	428
Houghton	6	252	276
Huron	4	102	142
Ingham	10	219	135
Ionia	7	303	407
Iosco	3	W	W

See footnotes at end of table.

Table 8.—Michigan: Sand and gravel sold or used by producers, by county, in 1976
—Continued

(Thousand short tons and thousand dollars)

County	Number of mines ¹	Quantity	Value
Iron	4	89	76
Isabella	4	607	593
Jackson	3	219	455
Kalamazoo	9	762	1,545
Kalkaska	1	5	5
Kent	17	1,682	3,531
Keweenaw	1	18	36
Lake	2	55	69
Lapeer	6	522	777
Leelanau	3	W	W
Lenawee	5	614	1,021
Livingston	17	2,558	3,046
Luce	2	W	W
Mackinac	7	218	185
Macomb	6	1,014	2,259
Manistee	3	125	82
Marquette	5	626	1,124
Mason	2	W	W
Mecosta	3	291	320
Menominee	4	67	76
Missaukee	3	94	80
Monroe	2	W	W
Montcalm	7	249	420
Montmorency	3	W	W
Muskegon	3	744	2,394
Newaygo	5	56	86
Oakland	26	10,969	17,168
Oceana	5	439	1,010
Ogemaw	5	510	535
Ontonagon	1	80	30
Osceola	3	475	644
Oscoda	2	W	W
Otsego	3	75	113
Ottawa	13	1,617	2,487
Presque Isle	2	W	W
Roscommon	1	W	24
Saginaw	4	936	2,322
St. Clair	2	W	W
St. Joseph	5	402	463
Sanilac	2	W	W
Schoolcraft	3	77	67
Shiawassee	8	300	390
Tuscola	10	922	1,516
Van Buren	5	216	223
Washtenaw	12	2,598	2,779
Wayne	4	1,612	6,181
Wexford	4	523	1,295
Undistributed ²	2	4,850	6,567
Total ³	432	47,403	78,455

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

¹ Reflects only mines that have reported in response to the annual canvass of operators.

² Includes data withheld and some sand and gravel that cannot be assigned to specific counties.

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

Table 9.—Michigan: Industrial sand sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Glass -----	W	W	595	3,352
Molding -----	2,104	7,102	2,150	8,735
Blast -----	W	W	3	16
Fire or furnace -----	W	W	W	W
Engine -----	207	451	305	581
Chemical -----	--	--	W	18
Foundry -----	W	W	702	2,522
Metallurgical -----	W	W	1,339	3,765
Other uses -----	2,061	5,545	241	1,209
Total ¹ -----	4,372	13,099	5,336	20,198

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

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

Slag—Iron and Steel.—Michigan continued to be one of the Nation's leading producers of slag during 1976. Slag is categorized as a manufactured mineral, along with cement and lime, and is used by the construction industry. Edward C. Levy Co., located in Wayne County, processes all the slag from Ford Motor Co.'s Steel Div., Great Lakes Steel, and McLouth Steel.

Stone.—Five companies quarried dimension stone for rough construction, rubble,

dressed construction stone, and other uses during 1976. Output increased 3% to 7,559 tons valued at \$129,300. Crushed stone was produced by 38 companies at 45 quarries. Output increased 4% to 41.5 million tons valued at \$82.2 million. Michigan ranked sixth in the Nation for the production of crushed stone. Tables 10–11 provide detailed information on the type of stone quarried and its use in 1976 compared with 1975 data.

Table 10.—Michigan: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone total ¹ -----	7	138	8	129
Crushed and broken:				
Limestone -----	30,672	52,104	40,214	77,296
Dolomite -----	7,970	16,565		
Marl -----	85	153	66	156
Traprock -----	9	17	W	W
Other ² -----	1,202	4,822	1,197	4,751
Total ³ -----	39,938	73,662	41,477	82,202
Grand total ³ -----	39,946	73,800	41,485	82,331

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

¹ Includes limestone, dolomite, and sandstone.

² Includes granite and sandstone, and kinds indicated by symbol W.

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

Table 11.—Michigan: Production of crushed stone¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Flux stone -----	10,190	19,360	10,880	21,570
Lime manufacture ² -----	11,050	18,680	11,120	20,700
Cement manufacture -----	7,334	12,250	8,272	14,900
Concrete aggregate -----	5,075	8,648	4,531	7,643
Macadam aggregate -----	1,214	2,520	1,934	4,275
Roadstone -----	1,430	2,151	1,223	1,844
Bituminous aggregate -----	754	1,258	954	1,864
Dense-graded roadbase stone -----	796	1,633	829	1,779
Agricultural limestone -----	516	1,022	510	1,142
Riprap and jetty stone -----	255	409	375	730
Riprap -----	278	496	309	542
Surface treatment aggregate -----	120	290	119	280
Soil conditioning -----	85	153	66	156
Other uses ³ -----	842	4,787	853	4,775
Total ⁴ -----	39,940	73,660	41,480	82,200

¹ Includes limestone, marl, traprock, and sandstone.

² Includes stone used in chemical stone for alkali works and sugar refining.

³ Includes stone used for glass, refractory stone, paper manufacture, mineral food, filter stone, terrazzo and exposed aggregate, and other uses.

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

Sulfur.—Byproduct sulfur was recovered from crude petroleum by TOTAL Leonard, Inc., at its Alma Refinery and by Marathon Oil Corp. in Detroit during 1976. Production remained the same in quantity and decreased 2.3% in value from 1975.

Shell Oil Co. announced plans in 1976 to construct a \$6 million plant in Manistee County for the separation of sulfur from natural gas. The plant is expected to produce about 25 tons of sulfur per day, while "sweetening" natural gas from nine wells in the area.⁴ The sulfur conversion plant is necessary to meet environmental requirements and will allow Shell to produce and sell the sulfur as a byproduct. Construction is scheduled to begin in mid-1977.

Vermiculite.—Michigan's sole producer of exfoliated vermiculite continued to be W. R. Grace & Co. Production at the Dearborn (Wayne County) plant fell 14% in 1976, while value rose 3% compared with 1975. The manufactured product was used both in the construction industry and in agriculture.

METALS

Copper.—Native copper ores of the Keweenaw Peninsula in Michigan contain elemental copper found in amygdaloidal volcanic flows and conglomerate beds. The

district produced a considerable tonnage of copper in times past, but is now inactive. The area, however, is again being investigated for commercial production possibilities by a group including Homestake Copper Mining Co.

Strata-bound deposits are another important source of copper, possibly accounting for one-fourth of the world's resources. In the United States, the most important example of this type of deposit is the Precambrian Nonesuch shale in the Upper Peninsula of Michigan.⁵ Here, the copper occurs primarily as chalcocite in siltstones, shales, and sandstones. Such deposits are the scene of White Pine's mining operations.

A slump in the copper industry, which began in mid-1974, prevailed throughout 1975-76. Mine production at White Pine's mine in Ontonagon County for 1976 was on a curtailed basis at production levels geared to market conditions. The company shut down mine, mill, and related operations for 4 weeks starting in mid-November 1976, with the smelter continuing normal operations to consume a stockpile of accumulated concentrates; poor demand and generally weak prices were the significant factors affecting operations.

⁴ Manistee News-Advocate, Sept. 29, 1976.

⁵ Engineering and Mining Journal, V. 177, No. 6, June 1976, p. 74.

Table 12.—Michigan: Mine production (recoverable) of silver and copper

	1974	1975	1976
Mines producing: Lode -----	1	2	2
Material sold or treated: -----			
Copper ore ----- thousand short tons--	8,301	9,033	3,801
Production: -----			
Quantity: -----			
Silver ----- troy ounces--	642,944	632,336	310,837
Copper ----- short tons--	67,012	73,690	43,707
Value: -----			
Silver ----- thousands--	\$3,028	\$2,795	\$1,352
Copper ----- do-----	103,601	94,618	60,840
Total ----- do-----	106,629	97,413	62,192

On January 5, 1976, the output of the White Pine mine was reduced by approximately 75%, from a production rate of 25,000 tons of ore per day to about 6,300 tons per day. The curtailment of operations required the layoff of a substantial number of employees. Production levels were changed several times during the year to balance refined copper production with market demand and to control inventories of finished product. Mine production ranged between a low of 24.5% of design capacity in February and a high of 59.4% in November.

Renovation of the southwest shaft of the mine and construction of related surface facilities were completed during 1976. However, production from the facility was delayed by the curtailment of mine production. Hoisting of ore from development mining began on September 1, and by yearend, 54,000 tons of ore had been hoisted at an average grade of 33 pounds of copper per ton of ore.⁶

According to the 1976 Annual Report of the Copper Range Co., White Pine copper mine produced an average of 10,806 tons of copper ore per day at an average grade of 27.7 pounds of copper ore per ton. The average price received per pound was \$0.69 compared with \$0.58 in 1975.

Despite numerous variations in volume, White Pine's mill operated at a record recovery rate of 87.78% of the contained copper, the highest yearly average ever recorded at the mine. As an experiment during the year, the mill successfully processed the first of some 300,000 tons of smelter slag (waste) by blending controlled amounts of such slag with mine ore and running the mixture through the mill. The slag yielded approximately 625,000 pounds of additional copper. This experi-

ment suggests an additional source from which copper can be recovered in the future.

At the end of 1976, proven extractable reserves at the White Pine mine were estimated to be approximately 90.3 million tons of copper sulphides and native copper ore with an average grade of 1.17% copper.⁷ The estimate has been calculated using a 1% copper cutoff and includes only reserves to a depth of 2,200 feet, the present maximum depth at which mining has been carried on. In addition, the company estimates that a probable extractable ore reserve of approximately 122 million tons with an average grade of 1.11% copper exists at levels between 2,200 and 3,500 feet, at which the company believes mining operations can be successfully conducted.

Copper Range Co., parent of White Pine Copper Co., approached Amoco Minerals Co., as well as several other companies, about possible sale of all or part of the Copper Range operations. As a result, the LL&E and Copper Range Co. announced plans to enter into a letter of intent looking toward a definitive agreement for LL&E to acquire all of the outstanding common stock of Copper Range. Copper Range has been seeking to sell all or part of its assets since 1975 because of a cash shortage.

Employees of the White Pine Copper Co., laid off since January 4, 1976, were certified as eligible for the federally funded and sponsored Trade Readjustment Assistance program. The program provides cash benefits, job retraining, and relocation assistance to employees laid off

⁶ Copper Range Annual Report, 1976, p. 7.

⁷ Copper Range Annual Report, 1976, p. 8.

because of the impact of imports on production and employment within a firm. Regular unemployment benefits run out for most of the workers in January 1977.

CCI, serving as the managing partner in a joint venture with Chevron Oil Co., continued to explore the copper potential of the Kona Dolomite in Marquette County. The area under study is near the eastern end of the Marquette Synclinorium where CCI controls a large block of mineral lands. The new joint venture, established during the latter part of 1975, will build on information obtained from previous exploration.

Iron Ore.—Iron ore is produced at four open pits and two underground mines in Michigan. Producers are CCI at four locations in Marquette County, Inland Steel Co. in Iron County, and Hanna Mining Co. in Dickinson County.

Pellet output from CCI's Michigan operations during 1976 amounted to 14.5 million tons, an increase of 18% compared with the 1975 figure of 12.3 million tons.⁸ The Tilden, Empire, and Republic mines reported record production during the year. Natural ore production from the Mather B mine, CCI's only operating underground mine, totaled 1.7 million tons, of which 1.4 million tons was delivered to the Pioneer pellet plant for pelletizing.

Shipments from the Sherwood underground mine, operated by Inland Steel Co., amounted to 305,950 gross tons of coarse and fine ore in 1976.⁹ Output from this property is railed to the Port of Escanaba for transfer to vessels.

Iron ore shipments from Hanna Mining Co.'s Groveland mine amounted to 1.9 million tons in 1976, compared with 2 million tons in 1975.¹⁰

CCI confirmed plans during 1976 for expansion of both the Empire and Tilden mines, as well as related electric generating facilities in the Upper Peninsula. When completed in 1979, the expansions will represent an investment totalling approximately \$750 million. The expansion program will increase annual iron ore pellet production by 2.8 million tons at Empire and 4 million gross tons at Tilden. In conjunction with the mine expansion programs, CCI is constructing three 80-Mw steam turbine generating units at Marquette. These units will furnish power

for the expanded mine projects, plus additional power requirements for present mining operations.

Participants in the Empire mine are Inland Steel Co., McLouth Steel Corp., International Harvester Co., and CCI, which serves as manager of the operation. Current design capacity at Empire is 5.2 million tons per year. Production from the expanded facility is slated to begin about January 1, 1980. The expansion will add about 475 jobs at the mine, for a total workforce of about 1,500 workers.

The Tilden mine is a joint venture of the Algoma Steel Corp. Ltd., Jones & Laughlin Steel Corp., Sharon Steel Corp., the Steel Co. of Canada Ltd., Wheeling-Pittsburgh Steel Corp., and CCI, which manages the operation. Earlier in 1976, CCI stretched out preliminary work for expansion at Tilden to provide additional time for evaluating operations at the mine's existing concentrating and pelletizing plant, which was completed in 1974. The delay was attributed to difficulty in controlling moisture levels of iron ore concentrate in the filtering section of the plant. According to company officials, the problem has been successfully solved.

The installation of a new primary crusher in the pit vertical footwall, approximately 500 feet below the surface at CCI's Republic mine, was completed in 1976. A 3,600-foot conveyor tunnel through the footwall of rock to convey the ore from the primary crusher to the secondary crushing system on the surface is an integral part of the new system. The \$14 million project is expected to minimize truck haulage requirements and result in greater efficiency and increased productivity.

CCI and Republic Steel entered into an agreement during 1976 for a research and development program working toward possible development of the Cascade iron formation in Marquette County. CCI is the principle owner of the property and will serve as manager of the project. Plans call for continued drilling and laboratory and pilot plant testing which could lead

⁸ Cleveland-Cliffs Iron Co. Annual Report, 1976, p. 4.

⁹ Skillings' Mining Review. V. 66, No. 5, Jan. 29, 1977, p. 13.

¹⁰ Skillings' Mining Review. V. 66, No. 12, Mar. 19, 1977, p. 6.

to development of the iron ore reserve in the 1980's. Initial investigations indicate that Cascade has reserves for sustaining a 4-million-ton-per-year mine, similar to the present Tilden operation.¹¹

Iron Oxide Pigments.—Increased shipments of crude iron oxide pigments in Michigan reflected the growing recovery of the automotive industry during 1976. CCI's operation in Marquette County reported increases of 44% and 42% in quantity and value. The primary use of the

red iron oxide pigments is the manufacture of paint.

Production of finished iron oxide pigments began at the new BASF Wyandotte Corp. facility in Wyandotte, Wayne County, during 1976. The plant, owned by BASF Wyandotte, is controlled by its Colors and Chemicals Div. located in New Jersey. Production included both synthetic red and yellow iron oxide.

¹¹ Cleveland-Cliffs Iron Co. Annual Report, 1976, p. 6.

Table 13.—Michigan: Usable iron ore¹ 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 ²	Iron content	
1854-1971 -----	399,598	295,350	249,625	944,568	NA	NA
1972 -----	9,131	2,533	--	11,664	7,332	62.86
1973 -----	9,036	2,404	--	11,440	7,210	63.02
1974 -----	8,920	2,419	--	11,339	7,153	63.08
1975 -----	12,443	2,331	--	14,774	9,327	63.13
1976 -----	14,663	2,318	--	16,980	10,759	63.36
Total -----	453,786	307,355	249,625	1,010,765	NA	NA

NA Not available.

¹ Exclusive after 1905 of iron ore containing 5% or more manganese.

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

³ Distribution by range partly estimated before 1906.

Table 14.—Michigan: Iron ore shipped from mines
(Thousand long tons)

Year	Direct-shipping ore ¹	Concentrates and agglomerates, total	Total usable ore ²	Proportion of beneficiated ore to total usable ore (percent)
1972 -----	727	11,965	12,692	94.3
1973 -----	463	11,927	12,389	96.3
1974 -----	548	11,054	11,602	95.3
1975 -----	288	13,801	14,089	98.0
1976 -----	356	15,888	16,245	97.8

¹ Includes crushed, screened, and sized ore not further treated.

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

Iron and Steel Scrap.—A \$3.2 million expansion project at the East Jordan Iron Works foundry in Charlevoix County was announced in February 1976. The expansion will increase the company's mold-making capacity and necessitate the hiring of an additional 50 workers. The plan was presented to the city council at a public hearing required as part of the company's application for an Industrial Facilities Exemption Certificate, giving the company a 12-year tax break on the expansion. The expansion will bring an automated mold line into the foundry, which will produce 600 molds per hour rather than the 100 under the present system. The expansion work was due to be completed in September 1977.

Campbell, Wyant, and Cannon (CWC) Foundry of Muskegon completed a \$16 million modernization program involving its Henry Street plant. The modernization program provides the plant with new melting equipment, automatic molding facilities, a new core room, and new cleaning and finishing equipment. The renovation program involved complete modernization of the foundry. The improvement program was approved by the CWC parent company, Textron, Inc., to strengthen the plant's position in the foundry industry.

Learning to cope with persistent shortages of essential raw materials has been perhaps the biggest challenge facing American manufacturing firms in the past few years. Springport Steel Products Co.'s situation became so critical that the container firm has gone into partnership with another wire-using firm to build their own steel-making plant at Springport, in Jackson County. The new plant is being built jointly by Springport Steel and Tri-State Engineering and Manufacturing Co. of Washington, Pa. The plant is thought to be the first such cooperative effort by steel-using companies to meet material needs. The new plant melts scrap steel in four 3,000° electric induction furnaces and then rolls 6-inch-square billets, each 56 inches long, into 1,300-foot coils of 11/32-inch steel rod. When completed, the plant should employ about 60 workers on 3 shifts and will be able to produce 300,000 tons of rod per year. The company decided to begin work on its own rod foundry in November 1973, when it was able to buy a surplus rod rolling mill

from Bethlehem Steel Corp. Springport Steel will use about one-seventh of the steel rod produced from the plant. The remainder will be used by Tri-State, which operates a container plant in Adrian.

Hoover-Ugine Co., a joint venture of Hoover Ball & Bearing Co. and a subsidiary of the French firm Pechiney Ugine Kuhlman, was closed on December 31, 1976, because of technical difficulties relating to production. The venture, a 50-50 partnership formed in 1973, has been manufacturing wire rod from scrap using a patented process. The process, initially developed in the United States through the facilities of Battelle Memorial Institute, involves the cleaning, shredding, and compacting of scrap steel and the heating—but not melting—of billets made from that material. The billets are then extruded into rod, which is wound into coils for shipment to customers. In the fall of 1973, Hoover executives anticipated that annual sales capacity of the plant would be about \$22 million. The plant, located at Bridgeman, could not produce enough wire rods to break even and could not get enough uniform scrap metal to make the process work. Hoover-Ugine had employed 110 workers, of which 43 were laid off in September and another 60 were let go when the plant closed. The remaining workers are in management positions and will continue to explore possible alternative uses for the plant.

Officials of Huron Casting Inc., located in Huron County, finalized an \$800,000 loan agreement in October 1976 for the construction of a new foundry at Pigeon. The firm, initially employing 35 workers, will produce steel castings for excavation and farm equipment. Melting, as well as the manufacture of patterns and molds, will take place at the foundry.

A \$4 million general contract for the construction of a new foundry was awarded by officials of the Eaton Corp.'s Saginaw plant. Projected to be one of the most modern facilities of its type in the world (hardenable iron casting), the foundry will occupy land at the southeast corner of the present complex. A scheduled construction completion date of May 1977 was set, with full operation expected by late 1977. Called a Disamatic, or DISA, foundry for the type of automatic molding machines to be installed, the facility will

provide about 40 new jobs. Besides the DISA molding machines, the foundry will be equipped with new melting furnaces, a new sand system, and pollution control devices.

Pig Iron and Steel.—Michigan's production of raw steel in 1976 amounted to 10.4 million net tons, a 14% increase over the 9.1 million tons recorded in 1975, according to the American Iron and Steel Institute. With a total of 7.7 million tons, Michigan placed fourth in the national ranking of pig iron consumption during 1976. Pig iron production in 1976 amounted to 7.4 million tons, compared with 7 million tons in 1975. Value of pig iron rose to \$1.3 million, a 2.7% gain over the comparable 1975 figure.

After 2 years of site evaluation, North Star Steel Co., jointly owned by Cargill Inc. of Minneapolis, Minn., and Co-Steel International of Canada, selected Monroe as the location for its new minimill. The \$50 million plant will eventually employ more than 1,000 workers. The electric furnace was in the planning stages at the close of 1976.

Ford Motor Co. opened two new electric steel furnaces in 1976 which will add 500 jobs at the firm's Rouge manufacturing complex. When in full operation, each furnace will run 24 hours per day and produce a 200-ton batch of molten steel every 4 hours. The two units can produce 750,000 ingot tons per year, adding 25% to Ford's current steel capacity of 3 million tons. The new furnaces complete a 12-year expansion and modernization program for Ford's Rouge steel operations. Ford is the only U.S. automaker to produce its own steel for motor vehicles.

McLouth Steel Corp. announced a reorganization of its stainless steel operation into a separate division in 1976, aiming at an annual production of 80,000 tons of stainless-sheet and -strip steel. The facility, located in Detroit, employs approximately 400 persons and is equipped with \$25 million of technological improvements.

Jones and Laughlin Steel Corp. (J&L) announced the closing of its Warren plant at the end of 1976 because the company has quit producing stainless bar, rod, and wire products. According to company officials, prices for their products have been depressed for several years as the result of heavy imports. The closing

affected about 550 salaried and hourly workers at the plant, which employed about 1,200 when operating at full capacity. J&L workers were certified eligible for assistance under the Trade Readjustment Assistance Act of 1974. The J&L plant was a major producer of stainless steel in Michigan.

Silver.—Production of silver at White Pine Copper Co.'s facility in Ontonagon County continued during 1976. Production dropped substantially, down 51%, while value fell by 52% below 1975. The decrease in production is directly related to the decrease in copper output at the White Pine facility.

Uranium.—TVA has joined International Nickel Co. (INCO) in a uranium exploration program covering 200,000 acres of northwestern Michigan. The acreage, which is centered in Baraga and Marquette Counties and extends into Iron County, was leased from Ford Motor Co. in 1975 for a period of 50 years. Under the pact, TVA has first rights to INCO's share of production in the event the property proves commercially feasible. Ford may participate in the exploration venture to the extent of a 10% interest and will earn a royalty up to 10% in any production operation. An estimated \$500,000 will be spent on exploration work.

A report evaluating the uranium and thorium potential of the Upper Peninsula of Michigan and northern Wisconsin was prepared by Michigan Technological University under a grant from ERDA. The report contains a discussion of the background geology and the mode of occurrence of uranium and thorium in the Precambrian. The Michigan Technological study was part of the ERDA Grand Junction Office's ongoing national uranium resource evaluation program.

CCI and Chevron Oil Co. formed a joint venture in 1976 to explore for uranium and base metals in Michigan's Upper Peninsula.

MINERAL FUELS

Coal.—The State's sole producer of coal, Michigan Aggregate Corp., suspended operations at its small strip mine located in Ingham County. During its 2-year operation, the mine produced approximately 20,000 tons of coal, all of which was sold to a local utility company.

Early in 1976, Detroit Edison Co., a Michigan power company, finalized a 26-year contract with Decker Coal Co. of Montana for the supply of about 200 million tons of western coal. The tonnages required by Detroit Edison for use in two electric generating facilities are scheduled to increase steadily from 3.9 million short tons in the first 2 years (April 1976 to April 1978) to reach 7.6 million short tons during April 1980-81, and 8 million tons in the years thereafter.

In June 1976, Michigan Technological University completed a study of Michigan's coal reserves under a contract with the Federal Bureau of Mines. The increasing demand for energy products and the proximity of the Michigan coal basin to potential markets has revived interest in this region. The study is a compilation centered around the quality and quantity of Michigan's coal, with special emphasis given to those considerations which bear on the future development potential of this resource.¹²

Coke and Coal Chemicals.—Three companies operated oven-coke plants in Michigan in 1976. They are Allied Chemical Corp., Ford Motor Co., and Great Lakes Steel Corp. All transfer coke to integrated operations and affiliated companies. The majority of the coke was consumed by blast furnaces. Coal-chemical materials produced at these coke plants include crude coal tar, diamonium phosphate, sodium phenolate, and crude light oil.

In July 1976, Allied Chemical Corp. announced plans to spend \$45 million to modernize its Semet-Solvay Div.'s coke oven plant along the Detroit River. Completion of the project is scheduled for the end of 1977.

Natural Gas.—Gas production, which began an upward surge in the mid-1950's, has continued to steadily climb. Production in 1976 amounted to 120,250,528 Mcf (thousand cubic feet) and is expected to other few years.¹³ Average daily gas production continued an upward trend for at least a decade in 1976 amounted to 329,429 Mcf, according to the Petroleum Geology Unit, Michigan Department of Natural Resources. Natural gas production and value follow in table 15.

Natural gas imports to Michigan markets and gas storage fields in 1976 by way of interstate pipelines amounted to 793,678,469 Mcf, a slight decrease from the 840,412,900 Mcf imported in 1975. These imports primarily come from Texas, Louisiana, Kansas, and Oklahoma gasfields.

¹² Kalliokoski, J. *Magnitude and Quality of Michigan's Coal Reserves* (Research Grant No. G0155165). BuMines Open File Rept. 102-76, 1976, 33 pp.; available for consultation at the Office of the Assistant Director—Fuels, Columbia Plaza, Washington, D.C.; the Eastern Field Operation Center, Pittsburgh, Pa.; Michigan Department of Natural Resources, Geological Survey Division, Lansing, Mich.; Michigan Technological University, Houghton, Mich.; The Hoyt Public Library, Saginaw, Mich.; and the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.

¹³ Michigan Manufacturer and Financial Record. V. 139, No. 5, May 1977, p. 16.

Table 15.—Michigan: Natural gas production and value, by county

County	1975		1976	
	Quantity (million cubic feet)	Value ¹ (thousands)	Quantity (million cubic feet)	Value ¹ (thousands)
Allegan	49.4	\$81.3	24.5	\$21.5
Antrim	1,894.8	884.3	1,060.5	931.1
Calhoun	5,024.2	3,185.3	4,932.5	4,330.7
Clare	112.6	71.4	79.2	69.5
Crawford	598.1	379.2	976.3	857.2
Eaton	2,950.0	1,870.3	3,956.8	3,474.1
Grand Traverse	19,842.9	12,580.3	33,484.3	29,399.2
Gratiot	2.3	1.5	2.6	2.3
Hillsdale	4,507.5	2,857.8	4,084.8	3,536.5
Ingham	3,991.0	2,530.3	4,048.0	3,554.1
Jackson	2,316.3	1,468.5	2,553.3	2,241.8
Kalkaska	36,313.2	23,022.6	29,522.1	25,920.4
Kent	6.1	3.9	3.8	3.3
Lapeer	33.6	21.3	22.0	19.3
Livingston	1,361.0	862.9	1,203.6	1,056.8
Macomb	324.3	205.6	235.1	206.4
Manistee	1,956.1	1,240.2	11,279.0	9,903.0
Mason	3,927.9	2,490.3	4,581.2	4,022.3
Mecosta	14.5	9.2	44.6	39.2
Missaukee	632.2	400.8	588.3	516.5
Oakland	1,327.0	841.3	916.8	805.0
Ogemaw	254.3	161.2	205.5	180.4
Osceola	56.1	35.6	153.9	135.1
Otsego	10,601.0	6,721.0	11,122.6	9,765.6
Ottawa	51.5	32.7	--	--
Roscommon	370.3	234.8	322.0	282.7
St. Clair	2,843.0	1,802.4	2,087.5	1,832.8
Tuscola	--	--	35.0	30.7
Wexford	1,817.0	1,152.0	2,721.3	2,389.3
Total ²	102,678.2	65,098.0	120,250.1	105,579.6

¹ County values calculated by using State average value per Mcf: \$0.634 for 1975 and \$0.878 for 1976.

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

Source: Michigan Department of Natural Resources, Division of Geology, Petroleum Geology Unit.

Pipelines.—In mid-June 1976, gas began flowing to the Albion plant of the Malleable Iron Div. of Hayes-Albion Corp. The pipeline runs from the Albion plant to three gas wells in Eaton County. The private line runs for 32 miles and cost approximately \$1.5 million. This project is unusual because Shell and Amoco, as producers, have negotiated a contract to sell the gas directly to the end user, Hayes-Albion Corp. The arrangement is not unique in Michigan's petroleum history, but it is a "first" for natural gas.

Consumers Power Co., a Jackson-based utility, has contracted with Mid-America Pipeliners, Inc., to construct approximately 1 mile of 12-inch pipeline to connect 12 wells at a gas storage field in St. Clair County. The pipeline, estimated at a cost of \$160,000, is part of an overall project costing approximately \$5.45 million. Consumers will be able to increase storage capacity in various parts of Michigan to up to 123.6 billion cubic feet by early 1977.

In October 1976, the Federal Power Commission authorized Great Lakes Gas Transmission Co. of Detroit to build a \$2.5 million, 15-mile natural gas pipeline across the U.S.-Canadian border at St. Mary's River between Michigan and Ontario. The pipeline will be the second crossing of the river and would be adjacent to the existing pipeline.

On June 7, 1976, the Michigan Public Service Commission (MPSC) approved 22.6 miles of new gas pipelines for Michigan Consolidated Gas Co. in Kalkaska, Grand Traverse, and Manistee Counties. Michigan Consolidated's lines will transport sour gas to sweetening facilities in a three-county area. The design specifications of the proposed pipelines were reviewed by MPSC to insure public safety in transporting the toxic gas.

Storage.—The first underground gas storage project in Michigan was completed by the Michigan Consolidated Gas Co. at the depleted Austin gasfield in Mecosta County in 1941. By the end of

1976, Michigan had 37 underground storage reservoirs with a total working capacity of 529.3 billion cubic feet.¹⁴ This accounts for over 15% of the Nation's total working storage capacity.

Gas storage made news in the winter of 1976-77, when fuel shortages throughout the midwest forced schools and factories to close. Michigan was spared many of these problems because gas stored in the underground reservoirs during the summer months was withdrawn when needed to meet the unusually high demand of a harsh winter.

Consumer Power Co. announced plans to expand its gas storage facilities by almost 10% with the award of a \$160,000 pipeline contract to a Michigan firm in June of 1976. Pipeline work began in June and was completed in September, completing conversion of the Hessen storage field and connection of 12 wells in St. Clair County. The Hessen field will hold a working volume of 10 to 12 billion cubic feet of gas and can be expanded later. The gas will be supplied by the utility's major suppliers, mainly Panhandle Eastern Pipe Line Co., Trunkline Gas Co., and some Michigan sources.

Two additional gas storage reservoirs, the Marsac Creek and the Capac, are scheduled for conversion in 1977-78. Marsac Creek will be operated by Consumers Power Co. in St. Clair County and will have a working capacity of 3.3 billion cubic feet. Capac, with a working capacity of 30.0 billion cubic feet, will be operated by Michigan Wisconsin Pipeline Co.

Refineries.—Shell Oil Co. installed a stabilizer column and associated equipment at its Kalkaska gas plant during 1976. The new equipment is designed to prevent wax buildup in processing equipment. It will allow the plant to operate at design efficiency while processing gas well condensate with high wax content produced from the Niagaran Trend fields.

Consumers Power Co.'s Marysville synthetic gas reforming plant, one of the world's largest, produces some 20% of the utility's annual gas requirements. Marysville manufactures methane gas by reforming liquid hydrocarbons through a catalytic process originally developed by the British Gas Council. Supplies of the light hydrocarbon feedstocks are drawn from both Canadian and Michigan suppliers. The Marysville gained some atten-

tion when it was being built between 1971-74 because of labor difficulties. During that period, the construction cost for the facility more than doubled the original estimates. The plant first began production of natural gas in July 1973, but actual completion of the facility did not occur until April 1974.

Because of its dependence on imported feedstocks and the increased construction costs at the Marysville plant, Consumers Power's natural gas rates are higher than any other utility in Michigan. During 1976, the State Attorney General's Office recommended closing the Marysville facility. Company officials, however, stated that the plant will remain in operation at least until 1980, when the present Canadian contract expires.

Natural Gas Liquids.—The amount of liquids produced from gas-condensate reservoirs associated with western and northern Michigan reef traps continued to increase in 1976. Gas plants operated by Shell Oil Co. and Amoco Production Co. in Kalkaska County strip natural gas liquids from the gas. The liquids are then sold to another company through the Shell pipeline that terminates at Marysville.

Akron Hydrocarbons continued construction of a processing plant in Quanicasee (Tuscola County) with a rated capacity of 10 million cubic feet of gas daily. Plant design work began late in 1975 and actual onsite construction began early in the summer of 1976. Full-scale startup for the plant occurred in December 1976, with an initial daily throughput of 3 to 4 million cubic feet. The plant is expected to be operated at rated capacity before the end of 1977. Dry natural gas from the facility will enter a new, recently completed Southeastern Michigan Gas Co. pipeline. Butane removed from the feedstock will be delivered to Niles, and propane and condensate will be taken by Wilson Propane. In addition to the Akron-Salina field production, the plant is capable of processing an additional 20,000 gallons daily of outside liquids. At rated capacity, the plant is expected to yield 45,000 gallons of liquids per day. Three original wells have been connected to the plant and two additional wells drilled early in 1976 await

¹⁴ Oil and Gas News, V. 83, No. 19, May 13, 1977, p. 21.

completion. Additional wells are programmed for 1977.

Oil Shale.—On October 1, 1976, The Dow Chemical Co. of Midland was awarded a \$13.6 million, 4-year grant from the ERDA to find a way to extract gas and oil from Michigan's Antrim Shale deposits. Antrim Shale is part of the Devonian Shale Formation that underlies many Eastern and Midwestern States, including 25,000 square miles of southern Michigan. The shale contains roughly 10 gallons of kerogen per ton, versus 25 to 40 gallons per ton in Colorado shale. For the past 20 years, Dow has been conducting a proprietary, experimental program with Antrim Shale supported by an oil shale development consortium in Michigan. Dow will contribute and utilize an 80-acre site near Crosswell in which \$877,000 has been invested. Current experiments involve drilling one initial well, then three additional observation wells. The total program calls for the drilling of eight wells, with extraction procedures on 40 acres to begin in the summer of 1977. To date, no long-term combustion of the Antrim Shale has been achieved. Although Dow estimates 2.5 trillion barrels of oil is trapped in the shale, company officials say commercial production from the formation still lies well in the future.

Peat.—Michigan remained the leading producer of peat in the United States during 1976, accounting for 31% of the U.S. total. Production, amounting to 300,103 tons, rose 22.5%; while value registered \$3.7 million, a 15.8% gain. Although both production and value rose over 1975, the average value per ton dropped from \$13.09 in 1975 to \$12.38 in 1976. Most of Michigan's peat is used as a soil conditioner, with the remainder used as an ingredient for potting soils, mushroom beds, and packing flowers.

Petroleum.—Michigan wells in 1976 produced a total 30.4 million barrels of crude oil and petroleum liquids, giving the State its best production year on record. The new alltime highs are principally attributable to Niagaran reef development, especially in the northern Lower Peninsula area spanning the State from Ludington to Rogers City. The most heavily developed and now on-line counties, including Mason, Manistee, Wexford, Grand Traverse, Kalkaska, Antrim, Crawford, and Otsego, accounted for almost 64% of all liquid hydrocarbons produced in Michigan during 1976. Oil production increased 24.6% over 1975. During 1976, Otsego County led the State as an oil-producing area, averaging 17,400 barrels daily.

Table 16.—Michigan: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Allegan	3	--	--	--	--	1	4	12,173
Antrim	--	--	--	--	--	2	2	9,076
Arenac	--	--	--	--	--	2	2	5,900
Barry	--	--	--	--	--	2	2	7,073
Bay	--	--	--	--	--	2	2	6,537
Benzie	--	--	1	--	--	1	2	11,938
Branch	--	--	--	--	--	1	1	3,610
Calhoun	6	2	9	2	4	12	35	119,177
Cass	3	--	1	--	--	--	4	2,800
Cheboygan	--	--	--	--	--	5	5	18,042
Clare	1	--	1	--	--	1	3	14,313
Crawford	1	--	2	2	1	1	7	49,576
Eaton	2	1	3	3	1	3	13	49,958
Gladwin	--	--	--	--	--	1	1	3,585
Grand Traverse	5	4	21	6	13	27	76	451,042
Gratiot	--	--	--	--	--	1	1	17,466
Hillsdale	10	--	--	--	--	--	10	40,275
Ingham	4	--	1	1	1	3	10	39,274
Ionia	--	--	--	--	--	2	2	5,770
Isabella	1	--	2	--	--	3	6	22,757
Jackson	--	--	--	--	--	2	2	8,275
Kalamazoo	--	--	--	--	--	1	1	4,080
Kalkaska	5	2	10	5	3	17	42	268,464
Lapeer	2	4	--	--	--	--	6	11,850
Macomb	--	11	3	--	2	13	29	96,825
Manistee	20	1	21	7	7	34	90	424,680
Mason	--	1	--	--	--	4	5	22,372
Mecosta	--	1	2	--	--	2	5	14,539
Midland	--	--	2	--	--	1	3	11,791
Missaukee	2	--	2	--	--	1	5	22,389
Montcalm	--	--	1	--	--	4	5	17,589
Montmorency	--	--	--	--	--	5	5	23,276
Oakland	--	--	--	--	1	3	4	17,048
Oceana	2	--	2	--	--	1	5	13,017
Ogemaw	11	--	--	--	--	5	16	46,847
Oscola	--	1	--	--	--	--	1	1,602
Otsego	6	--	12	2	1	31	52	286,032
Ottawa	--	--	--	--	--	2	2	7,119
Presque Isle	--	--	--	--	2	6	8	24,098
Roscommon	--	--	1	--	--	--	1	4,587
St. Clair	--	--	--	--	--	6	6	14,870
St. Joseph	--	--	--	--	--	2	2	1,880
Sanilac	--	--	--	--	--	2	2	13,347
Shiawassee	--	--	--	--	--	1	1	7,672
Tuscola	1	--	--	--	--	--	1	2,589
Van Buren	1	--	--	--	--	2	3	5,339
Wexford	3	--	2	1	--	2	8	49,942
Total	89	28	99	29	36	217	498	2,312,462

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Table 17.—Michigan: Crude oil production and value, by county
(Thousand 42-gallon barrels and thousand dollars)

County	1975		1976	
	Quantity	Value ¹	Quantity	Value ¹
Allegan	111	1,194	127	1,372
Antrim	206	2,211	181	1,961
Arenac	188	2,017	188	2,041
Barry	10	111	9	101
Bay	194	2,079	185	2,002
Benzie	--	--	(²)	3
Calhoun	1,814	14,111	1,559	16,902
Cass	--	--	6	62
Cheboygan	--	--	(²)	2
Clare	331	3,556	302	3,269
Crawford	858	9,213	984	10,662
Eaton	177	1,904	272	2,945
Genesee	12	133	19	207
Gladwin	236	2,536	250	2,718
Grand Traverse	2,152	23,116	3,472	37,637
Graiot	5	56	10	103
Hillsdale	1,312	14,091	1,142	12,378
Ingham	2,463	26,449	2,410	26,122
Isabella	118	1,263	124	1,345
Jackson	432	4,641	369	3,997
Kalkaska	3,463	37,196	3,118	33,802
Kent	60	641	56	610
Lake	87	936	82	891
Lapeer	78	837	96	1,045
Livingston	1	15	2	25
Macomb	2	23	8	81
Manistee	1,041	11,179	5,150	55,824
Mason	284	3,047	291	3,149
Mecosta	37	392	31	338
Midland	167	1,791	158	1,714
Missaukee	655	7,032	636	6,896
Monroe	6	63	4	43
Montcalm	80	858	76	824
Montmorency	(²)	1	--	--
Muskegon	10	102	8	90
Newaygo	14	154	11	119
Oakland	33	358	44	474
Oceana	33	357	26	276
Ogemaw	509	5,471	555	6,016
Oscoda	369	3,960	248	2,685
Oscoda	(²)	8	1	9
Otsego	5,719	61,424	6,352	68,853
Ottawa	65	702	63	679
Ottawa	(²)	2	--	--
Presque Isle	356	3,821	382	4,134
Roscommon	17	181	17	182
Saginaw	1,029	11,055	1,066	11,560
St. Clair	5	56	6	60
Shiawassee	47	503	48	524
Tuscola	9	100	10	111
Van Buren	2	21	1	13
Washtenaw	4	43	5	56
Wayne	117	1,260	264	2,859
Wexford				
Total ³	24,420	262,270	30,421	329,768

¹ County values calculated using State average value per barrel: \$10.74 for 1975 and \$10.84 for 1976.

² Less than ½ unit.

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

Source: Michigan Department of Natural Resources, Division of Geology, Petroleum Geology Unit.

Total imports of crude oil to Michigan refineries in 1976 amounted to 36.8 million barrels, a slight decline from 1975 levels. Domestic imports from other States and foreign imports from Libya and Nigeria increased from 15.3 million barrels in 1975 to 19.4 million barrels in 1976. Imports of Canadian crude by way of pipeline from western Canada oilfields continued to decline, reflecting Canadian governmental restrictions on exports to the United States. Canadian imports amounted to 17.5 million barrels in 1976, compared with 22.3 million barrels in 1975.

The bulk of Michigan-produced crude oil goes to Michigan refineries, but some 7.8 million barrels was exported in 1976, compared with 6.9 million barrels in 1975.

Exploration and Development.—Companies and individuals bid \$523,026 in bonus cash for 10-year primary term oil and gas leases on 33,944.7 acres at the State lease auction in June 1976, with an average \$15.41 per acre. This figure compares with an average of \$8.73 per acre at the 1975 sale and the alltime high of \$32.79 per acre set in 1974. Interest centered on the offering of 6,799 acres located in Kalkaska County, the only area where every tract offered found a bidder.

Quanex Corp., formerly Michigan Seamless Tube Co. of South Lyon, formed a subsidiary, Arbuckle Corp., to acquire oil and gas leases on property in several counties in southeastern Michigan. Quanex has hired Wenner Petroleum of Denver to review computer data to determine the possibility of finding natural gas on the properties.

American Natural Gas Co. (ANG) announced the formation of a new exploration subsidiary, Michigan Natural Resources Co., in early 1976. The company will engage in gas and oil exploration in Michigan. The new company will purchase 325,000 acres of unexplored leases from its affiliate, Michigan Consolidated Gas Co., also an ANG subsidiary. Michigan Consolidated will have first call on all gas discovered by Michigan Natural Resources and will retain wells and producing acreage developed under the Michigan Consolidated banner. Company officials announced that the firm will permit greater flexibility in financing and directing the search for gas and oil in Michigan.

Michigan Audubon Society members rejected a proposed bylaw change which

would have prohibited drilling for oil on Audubon-owned bird sanctuaries. However, no drilling will be done on the Society's Bernard W. Baker Sanctuary in Calhoun County. Mobil Oil Co., through a letter dated before the vote was taken, withdrew its offer to lease the land for oil exploration and possible drilling. For more than a year, the several thousand members of the Society battled over whether to permit limited oil drilling within the 900-acre sanctuary.

Drillers trying to push the Michigan oil boom into Crawford County ran into difficulties during 1976 because much of that area is the National Guard's training area at Camp Grayling. The State is attempting to rescind oil leases on 1,365 acres at the site because they violate terms of a land grant restricting the area to military or recreation areas. The entire Camp Grayling area of about 135,000 acres in Crawford, Otsego, and Kalkaska Counties lies just south of an area where large oil deposits have been tapped.

Canada has asked and the U.S. State Department is cooperating in developing a proposal for a feasibility study by the International Joint Commission that involves oil and gas exploration and drilling in the Great Lakes. The Michigan Natural Resources Commission established a policy against drilling for oil and gas in waters of the State, including the offshore waters of Lakes Superior, Michigan, Huron, and Erie, as early as 1949. That policy was restated and reaffirmed in 1960. An agreement with the Province of Ontario prohibiting oil and gas drilling in the boundary waters of Michigan and Ontario was concluded in 1967. While Michigan has received many requests for permits to explore in State waters, all have been rejected, including sonic boom exploration requested as recently as 1975.

Pigeon River Country State Forest development and exploration continued as an issue of extreme interest during 1976. Shell Oil Co. has filed applications with the Michigan Department of Natural Resources (DNR) for permits to drill 10 Niagaran reef test wells in the area. All sites lie within the hydrocarbon development area established by a consent order and unitization agreement executed in June 1976 by DNR and leaseholders in Pigeon River. The order placed northern reaches of the forest off limits to drilling

through a 25-year extension and conversion of leases held by Shell, Amoco Production Co., and Northern Michigan Exploration Co. to nondevelopment status. Additionally, a tract immediately north of the development area was placed in "moratorium" status with leaseholders agreeing not to file for permits to drill there for at least 5 years. Through the June order and unit agreement, Shell was designated as operator in the development tract. Since June, several private landowners and other leaseholders in the development unit joined the agreement and consent order.

Action on a similar agreement between Getty Oil Co. and DNR is still pending. Getty's principal Pigeon River interests lie in the northern part of the forest. In December 1976, the company presented DNR with a proposal for a conversion and lease extension paralleling the agreement made with other companies.

During 1976, the Michigan Court of Appeals ruled that the State can deny oil and gas drilling permits, even on State land leased to private industry, for the development of these resources. The decision gives added strength to efforts by DNR to limit and control gas and oil drilling in the northern part of the Pigeon River Country State Forest.

Pipelines.—U.S. Filter Corp. announced that its unit, Williams Brothers Engineering Co., has been authorized by Dome Pipeline Corp. to prepare for the 1977 construction of a new \$140 million, 1,167-mile light hydrocarbon pipeline through North Dakota, Minnesota, Iowa, Illinois, Indiana, Michigan, and Ohio. The Cochin 12-inch pipeline starts near Fort Saskatchewan, crosses the U.S. border near Sherwood, N. Dak., and terminates at both Sarnia, Ontario, and Green Springs, Ohio. Construction of the U.S. section is sched-

uled for completion in December 1977, coinciding with the completion of the Canadian section of the line.

During 1976, two Michigan refineries indicated an interest in receiving crude oil by way of the Northern Tier Pipeline, according to an announcement from the Northern Tier Pipeline Co. Marathon Oil Co. (Detroit) and TOTAL Leonard, Inc. (Alma), whose refineries both have sour crude capabilities, indicated an interest in an aggregate of 45,000 barrels daily of Alaskan crude oil. Michigan is 1 of the 11 northern tier States that fall under the Alaska Natural Gas Transportation Act signed in 1976 by the President. Estimates by the Federal Power Commission indicating Michigan will fall 8.5% short of its total natural gas requirements in 1977 have stimulated interest in the pipeline as an alternative source of energy supply.

Refineries.—TOTAL Leonard, Inc., reported that its Alma refinery initiated a \$13 million modernization program in February 1976, with construction beginning in October. The new systems are expected to be on-stream by the end of October 1977. Included are units for waste heat recovery and gas recovery. A new sulfur removal plant will be installed and the fluid catalytic cracking unit will be expanded. The program is designed to increase gasoline yield from 50% to 67%, meet the Environmental Protection Agency's phasedown schedule for lead additives, and reduce energy consumption. Output at the refinery is 42,000 barrels per day.

In July 1976, Lakeside Refining Co. announced the awarding of a \$2 million contract from the Defense Department Fuel Supply Center. Lakeside will supply about 5 million gallons of jet fuel.

Table 18.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Cement Div., National Gypsum Co.	17515 W. Nine Mile Rd. Southfield, Mich. 48075	Quarry and plant	Alpena.
Dundee Cement Co	Box 317, Dundee, Mich. 48131	do	Monroe.
Medusa Cement Co., a division of Medusa Corp.	Box 5668, Cleveland, Ohio 44101	do	Charlevoix.
Clay and shale:			
Amcord Inc., Peerless Cement Div.	9333 Dearborn St. Detroit, Mich. 48209	Pit	Wayne.
Copper:			
White Pine Copper Co. ¹	Box 427, White Pine, Mich. 49971	Underground mine and plant.	Ontonagon.
Gypsum:			
Michigan Gypsum Co	2840 Bay Rd. Saginaw, Mich. 48601	Open pit mine and plant.	Iosco.
National Gypsum Co	325 Delaware Ave. Buffalo, N.Y. 14202	do	Do.
United States Gypsum Co	101 S. Wacker Dr. Chicago, Ill. 60606	Open pit mine	Do.
		Plant	Wayne.
Iron ore:			
Cleveland-Cliffs Iron Co. ²	504 Spruce St. Ishpeming, Mich. 49849	3 open pit mines, 1 underground mine, plants.	Marquette.
Hanna Mining Co	Star Route 1, Box 131, Iron Mountain, Mich. 49801	Open pit mine and plant.	Dickinson.
Inland Steel Co	Box 232, Iron River, Mich. 49935	Underground mine and plant.	Iron.
Iron and steel:			
Ford Motor Co	The American Rd. Dearborn, Mich. 48121	Plant	Wayne.
McLouth Steel Corp	300 S. Livernois Ave. Detroit, Mich. 48217	do	Do.
National Steel Corp	2300 Grant Bldg. Pittsburgh, Pa. 15219	do	Do.
Lime:			
BASF Wyandotte Corp	1609 Biddle Ave. Wyandotte, Mich. 48192	Limekiln	Do.
Detroit Lime Co., a division of Edward C. Levv Co.	8800 Dix Ave. Detroit, Mich. 48209	do	Do.
The Dow Chemical Co. Ludington Div.	2020 Dow Center, Midland, Mich. 48640	do	Mason.
Marblehead Lime Co., a division of General Dynamics.	300 W. Washington, Chicago, Ill. 60606	do	Wayne.
Natural gas processors:			
Consumers Power Co	212 W. Michigan, Jackson, Mich. 49201	Plant	St. Clair.
Michigan-Wisconsin Pipeline Co.	1 Woodward Ave. Detroit, Mich. 48226	do	Osceola.
Mobile Oil Corp	Box 258, Mason, Mich. 48854	do	Ingham.
Shell Oil Co	Two Shell Plaza, Box 2105, Houston, Tex. 66001	do	Kalkaska and Otsego.
Natural salines:³			
The Dow Chemical Co	2020 Dow Center, Midland, Mich. 48640	Brine wells and plant.	Mason and Midland.
Morton Chemical Co	110 N. Wacker Dr. Chicago, Ill. 60606	do	Manistee.
Velsicol Chemical Co., a division of Northwest Industries.	351 E. Ohio St. Chicago, Ill. 60606	do	Gratiot.
Peat:			
Al-Par Peat	9551 Krouse, Ovid, Mich. 48866	Bog and plant	Shiawassee.
Anderson Peat Co	332 Graham Rd. Imlay City, Mich. 48444	do	Lapeer.
Michigan Peat, Inc	Box 66388, Houston, Tex. 77006	Bogs and plants	Sanilac.
Petroleum refineries:			
Consumers Power Co	212 W. Michigan, Jackson, Mich. 49021	Refinery	St. Clair.
The Dow Chemical Co	2020 Dow Center, Midland, Mich. 48640	do	Bay.
Marathon Oil Co	1300 S. Fort St. Detroit, Mich. 48217	do	Wayne.
TOTAL Petroleum Inc	East Superior St. Alma, Mich. 48801	do	Gratiot.

See footnotes at end of table.

Table 18.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Salt:			
BASF Wyandotte Corp ----	1609 Biddle Ave. Wyandotte, Mich. 48192	Brine wells and plant.	Wayne.
Diamond Crystal Salt Co --	916 S. Riverside Dr. St. Clair, Mich. 48079	----do -----	St. Clair.
International Salt Co., Inc.	12841 Saunders St. Detroit, Mich. 48217	Underground mine-	Wayne.
Sand and gravel—construction:			
American Aggregates Corp.	Drawer 160 Greenville, Ohio 45331	Surface pits and stationary plants.	Kalamazoo, Livingston, Macomb, Oakland.
Grand Rapids Gravel Co ---	2700 28th St., SW. Grand Rapids, Mich. 49509	Surface pits and stationary plants.	Kent.
Holly Sand and Gravel Co., Aggregate Div. of J. P. Burrughs & Son, Inc.	Box 1468 Saginaw, Mich. 48605	Surface pit, sta- tionary and portable plants.	Oakland.
Western Materials, a division of Medusa Aggregates Inc.	4200 S. Milford Rd.—Box H New Hudson, Mich. 48165	Surface pit and stationary plant.	Do.
Sand and gravel—industrial:			
Manlev Bros. of Indiana, Inc.	Box 67 Chesterton, Ind. 46304	----do -----	Berrien.
Nugent Sand Co. Inc -----	Box 566, 2875 Lincoln Muskegon, Mich. 49443	----do -----	Muskegon.
Ottawa Silica Co -----	33620 Streicher Rd. Rockwood, Mich. 48173	----do -----	Wayne.
Sargent Sand Co -----	2840 Bay Rd. Saginaw, Mich. 48605	Surface pits, and plant.	Mason, Saginaw, Tuscola, Wexford.
Stone:			
Limestone Operations, U.S. Steel Corp.	Rogers City, Mich. 49779	Quarry and plant -	Presque Isle.
Presque Isle Corp -----	Box 426 Alpena Mich. 49707	----do -----	Do.
Cement Div., National Gypsum Co.	17515 W. Nine Mile Rd. Southfield, Mich. 48075	----do -----	Alpena.

¹ Also produces silver.² Also produces iron oxide pigments.³ Includes bromine, bromine compounds, calcium compounds, iodine, and magnesium compounds.

The Mineral Industry of Minnesota

By Ronald C. Briggs¹ and Wanda J. West²

The value of raw mineral output in Minnesota in 1976 increased for the fifth consecutive year to a record \$1.2 billion, 11% greater than the 1975 value. The total value of mineral output from the State was more than double that of just 5 years earlier, because of improved market conditions, inflationary pressures that increased unit values, and additional production capacity in the taconite industry.

Minnesota continued to lead the Nation in iron ore production, supplying 62% of the total iron ore shipped from U.S. mines. Although iron ore shipments from the State declined nearly 3% from those of 1975, the total value increased 12% to \$1.1 billion and comprised more than 93% of the total State mineral value. Sand and gravel and stone ranked second and third in contributing to Minnesota's mineral value, constituting 4% and 2%, respectively. The

combined value of nonmetallic minerals decreased 5% from that of 1975. Although all nonmetals produced in 1976 increased in value, the increase failed to offset the drop in value resulting from the closing of the State's only cement plant at the end of 1975.

Mineral production was reported from all counties in the State, except Jackson and Traverse. Sand and gravel was produced in each of the 85 mineral-producing counties, and stone in 25. St. Louis County, with its predominance of iron ore mines, ranked first in value of mineral production, followed by Itasca County. Twenty-two counties recorded mineral output valued in excess of \$1 million.

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² Liaison program assistant, Bureau of Mines, Twin Cities, Minn.

Table 1.—Mineral production in Minnesota¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	\$14	NA	\$15
Iron ore (usable)				
thousand long tons, gross weight...	49,167	1,015,272	47,874	1,137,733
thousand short tons...	W	W	103	2,794
Lime	108,749	W	202,271	W
Manganiferous ore	13	230	26	1,505
Peat	33,398	45,214	^a 33,486	^a 44,503
Sand and gravel	6,854	23,302	7,567	25,767
Stone				
Value of items that cannot be disclosed:				
Abrasive stone, cement (1975), clays (common and kaolin), industrial sand (1976), and values indicated by symbol W	XX	13,056	XX	5,713
Total	XX	1,097,088	XX	1,218,080
Total 1967 constant dollars	XX	434,118	XX	^b 437,882

^a Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes industrial sand; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Minnesota, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Aitkin	\$729	W	Peat, sand and gravel.
Anoka	W	W	Sand and gravel.
Becker	578	\$433	Do.
Beltrami	321	852	Do.
Benton	W	53	Do.
Big Stone	W	W	Stone, sand and gravel.
Blue Earth	W	1,915	Do.
Brown	W	W	Sand and gravel, clays.
Carlton	W	W	Peat, sand and gravel.
Carver	485	W	Sand and gravel.
Cass	194	581	Do.
Chippewa	395	371	Do.
Chisago	219	207	Do.
Clay	W	3,175	Sand and gravel, lime.
Clearwater	210	308	Sand and gravel.
Cook	466	W	Do.
Cottonwood	132	243	Do.
Crow Wing	W	W	Manganiferous ore, sand and gravel.
Dakota	W	W	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	142	318	Sand and gravel.
Fairbault	408	W	Do.
Fillmore	898	1,231	Stone, sand and gravel.
Freeborn	997	753	Sand and gravel.
Goodhue	819	368	Sand and gravel, stone.
Grant	W	W	Sand and gravel.
Hennepin	W	W	Sand and gravel, clays.
Houston	W	W	Stone, sand and gravel.
Hubbard	188	184	Sand and gravel.
Isanti	76	76	Do.
Itasca	109,804	130,165	Iron ore; sand and gravel, peat.
Jackson	127	--	
Kanabec	W	179	Sand and gravel.
Kandiyohi	689	899	Do.
Kittson	W	315	Do.
Koochiching	78	225	Do.
Lac qui Parle	285	216	Stone, sand and gravel.
Lake	105	W	Sand and gravel.
Lake of the Woods	600	56	Do.
Le Sueur	W	W	Sand and gravel, stone.
Lincoln	W	W	Sand and gravel.
Lyon	W	W	Do.
McLeod	311	73	Do.
Mahnomen	43	W	Do.
Marshall	W	W	Do.
Martin	249	60	Do.
Meeker	302	162	Do.
Mille Lacs	W	W	Stone, sand and gravel.
Morrison	662	552	Sand and gravel.
Mower	W	W	Stone, sand and gravel.
Murray	W	10	Sand and gravel.
Nicollet	W	W	Stone, sand and gravel.
Nobles	W	W	Sand and gravel.
Norman	W	W	Do.
Olmsted	1,434	1,966	Stone, sand and gravel.
Otter Tail	55	682	Sand and gravel.
Pennington	1	W	Do.
Pine	501	365	Do.
Pipestone	1	W	Do.
Polk	W	1,904	Lime, sand and gravel.
Pope	81	96	Sand and gravel.
Ramsey	W	W	Do.
Red Lake	259	61	Do.
Redwood	W	W	Sand and gravel, clays, stone.
Renville	W	W	Lime, stone, sand and gravel.
Rice	W	W	Sand and gravel, stone.
Rock	W	W	Sand and gravel, abrasives, stone.
Roseau	W	W	Sand and gravel.
St. Louis	920,693	W	Iron ore, sand and gravel, peat, stone.
Scott	2,361	2,661	Stone, sand and gravel.
Sherburne	1,415	1,578	Sand and gravel.
Sibley	W	W	Do.
Stearns	7,902	W	Stone, sand and gravel.
Steele	1,213	1,051	Sand and gravel, stone.
Stevens	W	W	Sand and gravel.
Swift	179	64	Do.
Todd	705	709	Do.
Traverse	W	--	

See footnotes at end of table.

Table 2.—Value of mineral production in Minnesota, by county—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Wabasha -----	W	\$494	Stone, sand and gravel.
Wadena -----	\$9	18	Sand and gravel.
Waseca -----	W	W	Do.
Washington -----	5,681	6,255	Sand and gravel, stone.
Watsonwan -----	12	W	Sand and gravel.
Wilkin -----	66	109	Do.
Winona -----	2,184	W	Stone, sand and gravel.
Wright -----	741	511	Sand and gravel.
Yellow Medicine -----	W	1,096	Stone, sand and gravel.
Undistributed ¹ -----	31,088	1,054,428	
Total ² -----	1,097,088	1,218,030	

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

¹ Includes some sand and gravel (1976) that cannot be assigned to specific counties, value of gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of Minnesota business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	1,799.0	1,865.0	+3.7
Unemployment -----do-----	107.0	110.0	+2.8
Employment (nonagricultural):			
Mining -----do-----	14.4	14.8	+2.8
Manufacturing -----do-----	312.9	317.5	+1.5
Contract construction -----do-----	63.6	65.1	+2.4
Transportation and public utilities -----do-----	89.1	90.1	+1.1
Wholesale and retail trade -----do-----	369.8	383.5	+3.7
Finance, insurance, real estate -----do-----	75.4	77.7	+3.1
Services -----do-----	277.5	291.2	+4.9
Government -----do-----	271.4	274.3	+1.1
Total nonagricultural employment -----do-----	¹ 1,474.2	¹ 1,514.3	+2.7
Personal income:			
Total -----millions--	\$22,597	\$24,515	+8.5
Per capita -----do-----	\$5,762	\$6,183	+7.3
Construction activity:			
Number of private and public residential units authorized -----do-----	19,162	26,973	+40.8
Value of nonresidential construction -----millions--	\$250.6	\$303.7	+21.2
Value of State road contract awards -----do-----	\$128.0	\$145.0	+13.3
Shipments of portland and masonry cement to and within the State -----thousand short tons--	1,519	1,601	+5.4
Mineral production value:			
Total crude mineral value -----millions--	\$1,097.1	\$1,218.0	+11.0
Value per capita, resident population -----do-----	\$280	\$307	+9.6
Value per square mile -----do-----	\$13,050	\$14,489	+11.0

^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.

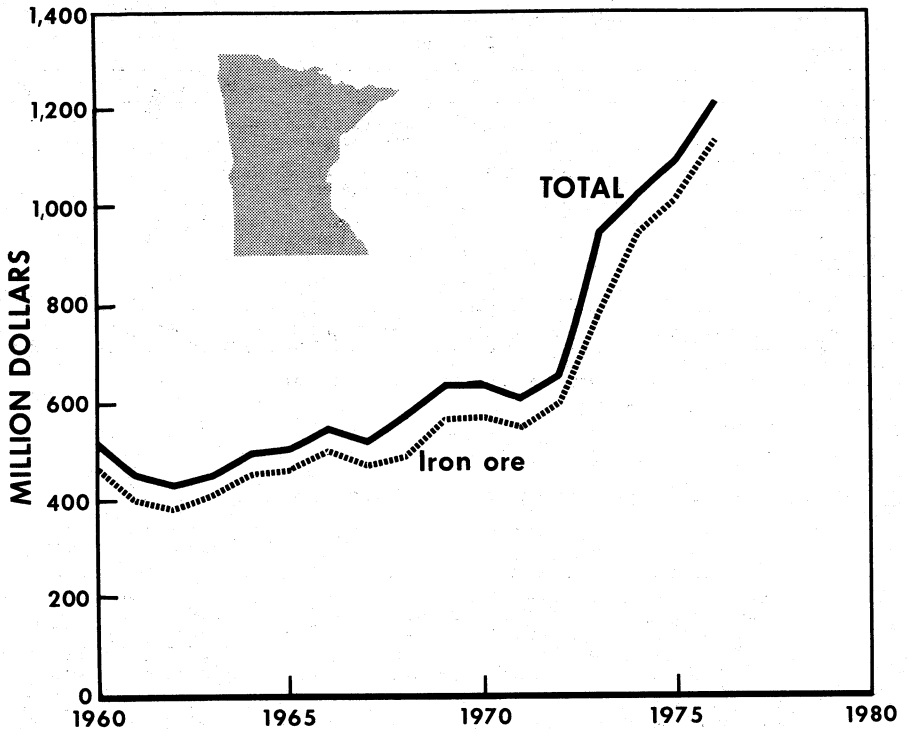


Figure 1.—Value of iron ore shipments and total value of mineral production in Minnesota.

During 1976, two of the five projects in the \$1 billion construction program at taconite plants on the Mesabi Range were completed. Eveleth Taconite Co. completed a \$255 million expansion of its operations which increased annual pellet capacity from 2.4 to 6.0 million tons. Testing of the new Hibbing Taconite Co. facilities was begun in mid-1976, and by yearend the plant was in operation. Construction at the plant continued, as part of a program that will increase the initial plant capacity of 5.4 million tons of pellets to 8.1 million tons in 1979. Total cost of the project was estimated at more than \$300 million. Construction continued at the new Minorca project of Inland Steel Mining Co. and on the expansion of the United States Steel Corp. and the National Steel Pellet Project taconite plants.

The search for copper-nickel in northeastern Minnesota continued; AMAX Explora-

tion, Inc., led the exploration activity, sinking an exploration shaft near Babbitt. The company plans to remove a 20,000-ton sample for testing before reaching a final decision regarding future operations. Meanwhile, State agencies are evaluating the potential environmental, economic, and social impact of copper-nickel mining on northern Minnesota.

Considerable attention continued to be devoted to Minnesota's vast peat resources. Although annual peat production from the State has rarely exceeded 20,000 tons, virtually all for horticultural use, Minnesota does have a substantial share of the peat resources in the contiguous 48 States. The current energy situation has prompted study of peat as a possible source for production of synthetic natural gas. The Minnesota Gas Co. received a \$1 million grant from the U.S. Energy Research and Development Administration (ERDA) for an ex-

perimental peat gasification project in northern Minnesota. The State of Minnesota, principally through the Division of Minerals, Department of Natural Resources (DNR), also undertook studies to inventory peat resources and to develop necessary management and regulatory expertise. These projects were carried on within the DNR and under contract to that agency with some financing from the Upper Great Lakes Regional Commission.

Employment and Injuries.—According to statistics published by the Minnesota Department of Employment Services, employment in the mining and quarrying industries at yearend 1976 totaled 14,400, nearly 10% more than at the end of 1975. More than 92% were employed in the metal mining industries.

Legislation and Government Programs.—A bill prohibiting the leasing of State land within the Boundary Waters Canoe Area (BWCA) for exploration or mining of minerals or harvesting of peat was enacted during the year (chapter 322). Subject to State legislative approval, an exception to the ban could be made in the event of a national emergency declared by the U.S. Congress, which directs the need for exploration and mining of Federal lands in the BWCA. The new law included an appropriation of \$147,000 to the Commissioner of Natural Resources for salaries, supplies, and expenses related to mined-land reclamation, including but not limited to the following: (1) Completion of development and promulgation of mined-land reclamation rules, (2) the development of administrative guidelines, procedures, and forms, and (3) the development of supply-demand land use evaluations of mining districts for use in analyzing and granting mining permits.

Chapter 303 provided for the creation of an Environmental Permits Coordination Unit within the Minnesota Environmental Quality Council (EQC). The unit will es-

tablish and maintain an information system to aid the public in meeting State and local requirements for permits relating to the use of natural resources, and will make available to the public information pertaining to Federal and State laws that must be satisfied prior to undertaking a project in the State. The unit will provide better coordination and understanding between State and local agencies in the administration of various programs relating to air, water, and land resources.

Under a measure enacted during 1976 (chapter 228), the Commissioner of Natural Resources and Lake and St. Louis Counties were granted the authority to sell necessary public land for the disposal of Reserve Mining Co.'s taconite tailings.

A Ramsey County District Court judge ruled that a 1973 State law allowing Minnesota counties to collect property taxes on the rights to minerals owned separately from surface property was constitutional. However, a portion of the law, which provided that a person who failed to register his mineral rights with the county would lose such rights, was ruled unconstitutional by the judge, who determined that this portion of the law denied "due process." The suit had been brought by 2 railroad companies, 5 financial institutions, and 10 other companies. The law stated that a tax of \$0.25 per acre was to be levied, with a minimum tax of \$2. Based on a Department of Natural Resources estimate, 10 million acres are involved, and the State will gain about \$2.5 million in revenue. The plaintiffs collectively hold severed mineral rights on all or portions of 1.3 million acres in 50 of the State's 87 counties. Most of the land is in northeastern Minnesota where there are known mineral deposits. Following a refusal by the judge later in the year to reverse his ruling, a spokesman for the mineral-rights owners said the case would be appealed to the Minnesota Supreme Court.

REVIEW BY MINERAL COMMODITIES

METALS

Copper-Nickel.—The abandonment of operations by the International Nickel Co., Ltd. (INCO) in the last part of 1975 delayed the possibility of copper-nickel min-

ing in the northeastern part of the State near Ely. The firm earlier projected that mining could begin in late 1978. Citing uncertain State environmental policy and changes in market conditions, the company abandoned its plan for what could have

been the first copper-nickel mining venture and withdrew, at least temporarily, all activity from the State. The INCO proposal was extremely controversial because it called for a 1,000-foot-deep, mile-long open pit near the environmentally sensitive Boundary Waters Canoe Area (BWCA). The company maintained its leases in the Superior National Forest and offered to reexamine its decision when State policies are finalized in 1980 or later.

Several other companies have leases in potentially valuable copper-nickel areas, but only INCO and AMAX Exploration, Inc., Denver, Colo., have indicated interest beyond preliminary exploration. AMAX Exploration continued exploration activities and began sinking a 1,710-foot exploration shaft at its Minnamax project about 4 miles south of Babbitt. On March 5, the shaft-sinking contract was awarded by the company to Centennial Development Co., Salt Lake City, Utah. The 14-foot-diameter test shaft is being sunk to evaluate a copper-nickel deposit identified through exploration drilling. Actual sinking of the shaft followed almost 2 years of environmental monitoring and project review by State agencies. When the shaft is completed, the company intends to drive three drifts and further explore the mineral deposit through underground drilling. AMAX also plans to remove a 20,000-ton ore sample for metallurgical testing purposes. At yearend, the shaft had been sunk nearly 700 feet. After analyzing the present exploration data, the firm anticipates a mine producing mostly copper with nickel as the major byproduct. The company does not intend to make a final decision on the method of mining until about 1981, but it could be underground, open pit, or a combination of both.

While AMAX continued its activity, State officials continued to study copper-nickel mining in Minnesota. The work of the Copper-Nickel Study Team under the direction of the EQC gained momentum during 1976. The study focused on a 560-square-mile area in St. Louis and Lake Counties where copper-nickel mining is most likely to occur. The primary thrust of the study is to determine the environmental impact

that mining would have on northeastern Minnesota, as well as to evaluate potential social and economic impacts affecting not only that specific region but the entire State. The final version of the study will go to the 1979 legislature and will provide a range of policy options and data to consider regarding copper-nickel mining in Minnesota.

The Minnesota Department of Natural Resources developed a new computerized mapping system for the 560-square-mile area under study by the EQC Copper-Nickel Study Team. The computer data will produce maps showing timber resources, types of wildlife habitat, surface characteristics, and mineral potential of any area in the copper-nickel region. The project, known as MINESITE, will permit evaluation of an area before mining has begun. Prior to establishing MINESITE, such surveys had to be made on the ground. Using the computer, the possibilities for any mining area in the region can be studied and evaluated without going to the site.

Iron Ore.—The 47.9 million long tons of usable iron ore shipped during 1976 was nearly 3% less than 1975 shipments; however, with a price increase for both taconite pellets and natural ore, the total value of shipments increased 12% to \$1.1 billion. Minnesota mines contributed 62% of the total usable iron ore produced in the United States. Pellet shipments from the six taconite plants totaled 39.1 million long tons, half a million tons more than in 1975. Shipments from 32 natural ore mines or mine groups comprised the remaining tonnage. Nearly all of the natural ore was beneficiated before shipment. All taconite and natural ore was produced from open pit operations in St. Louis and Itasca Counties, all on the Mesabi Range. One mine, the National Steel pit, extends into both counties.

The \$1 billion construction program in Minnesota's taconite industry was highlighted in 1976 by the completion of one new facility and the initial expansion of one existing plant, following 2½ years of construction and development work at each site.

Table 4.—Minnesota: Iron ore¹ data in 1976, by county and range
(Thousand long tons)

County and range	Crude ore production ²	Usable ore				
		Stocks Jan. 1	Production	Iron content of production	Shipments	Stocks Dec. 31
County:						
Itasca	20,503	271	6,661	3,967	6,559	372
St. Louis	123,186	3,611	43,103	26,561	41,315	5,899
Total ³	148,689	3,881	49,764	30,528	47,874	5,772
Mesabi Range	148,689	3,881	49,764	30,528	47,874	5,772

¹ Exclusive of ore containing 5% or more manganese.

² Entire production from open pit mines.

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

Table 5.—Minnesota: Production and shipments of usable iron ore¹
(Thousand long tons)

Year.	Production				Shipments			Proportion of taconite pellets to total ore (percent)
	Natural ore	Taconite pellets	Total ²	Iron content (percent)	Natural ore	Taconite pellets	Total ²	
1972	14,452	34,546	48,998	60.20	15,229	35,366	50,595	69.90
1973	18,420	41,601	60,021	60.53	19,013	43,601	62,614	69.63
1974	17,541	40,944	58,484	60.02	18,282	41,140	59,422	69.23
1975	10,466	40,711	51,177	60.58	10,553	38,615	49,167	78.53
1976	9,152	40,612	49,764	61.34	8,806	39,068	47,874	81.60

¹ Exclusive of ore containing 5% or more manganese.

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

Production began in midyear at the \$255 million expanded facilities of Eveleth Taconite. To meet the demand of the added 3.6-million-ton-per-year pellet capacity, a second pit was developed at the Thunderbird mine to supply 9.8 million tons of crude ore annually. The expanded capacity will be operated under Eveleth Expansion Co., which is 40% owned by Armco Steel Corp., 23.5% by The Steel Co. of Canada, Ltd., 16% by Dominion Foundries & Steel Ltd., and 20.5% by Oglebay-Norton Co. Interests held in Eveleth Taconite Co. are 85% by Ford Motor Co. and 15% by Oglebay-Norton Co. Full production at the annual rate of 6 million tons of pellets at the Eveleth operations is anticipated during 1978.

Testing of equipment at Hibbing Taconite Co.'s new 5.4-million-ton-per-year plant began in May, and by late August the first pellets were produced. The last of six grinding circuits was operating by year-

end to complete the plant startup. Initial shipment of pellets was scheduled for early 1977. Hibbing Taconite is owned 78.33% by Bethlehem Steel Corp., 15% by Pickands Mather & Co. (which is also the operating agent), and 6.67% by The Steel Co. of Canada. An expansion program, scheduled for completion in 1979, is underway to increase the facility's output by 50% to 8.1 million tons annually. Total cost of the Hibbing Taconite project is estimated at more than \$300 million.

The largest taconite expansion is at Mountain Iron, where United States Steel Corp. is increasing annual pellet capacity of its Minntac plant by 50%, to more than 18 million tons. The expansion program includes additions to the coarse and fine crushers, concentrator, and agglomerator and a new mobile equipment repair facility to service 120-ton haulage trucks. Construction, now estimated to cost in excess of \$300 million, is scheduled to be completed late

in 1977. To meet future production schedules that call for dumping a railroad car of crude taconite into the coarse crusher every minute, 24 hours per day, 7 days per week, additional mining and haulage equipment has been ordered.

Plant expansion at National Steel Pellet Project, operated by The Hanna Mining Co. at Keewatin, was approximately 99% complete at yearend. Some of the newly installed equipment was already in use, and modifications were being made to the older units. The \$155 million project will increase the plant's annual pellet capacity from 2.5 to 5.8 million tons. The Keewatin plant is owned jointly by National Steel Corp. (85%) and The Hanna Mining Co. (15%).

Construction continued throughout the year on Inland Steel Mining Co.'s Minorca taconite complex north of Virginia, with erecting and equipping of processing facilities and development of the mine area. Initial production from the \$150 million facility is slated for mid-1977, and it is expected to attain the designed production rate of 2.6 million tons of pellets annually in 1978. Inland Steel Mining Co. is a wholly owned subsidiary of Inland Steel Co., one-quarter of whose iron ore requirements will be met by Minorca at capacity operation of the plant. The Minorca operation will be the largest single source of iron ore for the furnaces operated by Inland Steel Co., replacing the firm's Caland operations in Canada.

An early cold spell brought a mid-October curtailment of natural gas to the taconite industry. The cutback of approximately 60% of the gas supply required companies to switch to backup alternate fuel systems but did not result in a decrease of production. Most plants will continue to use natural gas whenever it is available, with oil as a first alternative, but coal is seen as the most likely fuel of the future. The Hanna Mining Co. applied to the Minnesota Pollution Control Agency for permits to convert its National Steel Pellet plant near Keewatin from natural gas to oil and coal and to construct a coal-handling facility at the site. Both the new Inland

Steel Minorca plant and the Eveleth Expansion Co. unit are designed to use coal as the primary fuel for their pelletizing operations.

The Hanna Mining Co. closed its Whitney mine at Hibbing for an indefinite period at yearend. Limited demand for the type of ore produced at the Whitney was cited as the reason for closing the company's only active natural ore mine, which began production in 1974.

Lake Superior iron ore prices at the beginning of 1976 were unchanged from the level to which they had risen in mid-1975; namely, Mesabi nonbessemer, \$18.50 per ton (coarse, \$19.30; fine, \$18.05); Old Range nonbessemer and manganiferous, \$18.75; and Mesabi bessemer, \$18.65. However, a 4% increase in early January and a 5% increase in August, to compensate for increased operating costs, raised the price for each class by \$1.76 per ton. The foregoing prices were for ore delivered at rail-of-vessel at lower lake ports and were based on a natural iron content of 51.50%. Increases of nearly 7% in early January and 5% in August raised the lower lake price of pellets from the January 1 level of 47.2 cents per long ton iron unit to 53.1 cents, which was in effect the remainder of the year. The average weighted mine value for Minnesota iron ore was \$23.77 per ton, compared with \$20.65 in 1975.

According to rates published in mid-1976, the cost of transporting iron ore from the Mesabi Range to lower lake ports ranged from \$6.68 to \$7.22 per long ton. The rates include a dock handling charge of \$0.39 at upper lake docks but do not include handling charges at lower lake ports.

Minnesota iron ore was shipped year-round for the second consecutive year as vessels from the United States Steel fleet sailed continuously from Two Harbors to steel mills on the lower lakes. While other upper Great Lakes ports were closed at the end of a shipping season, iron ore shipments from Two Harbors began in the spring of 1974 and continued throughout that year as well as 1975 and 1976 without interruption.

Table 6.—Dates of first and final cargoes of Minnesota iron ore shipped from upper Great Lakes ports

Port and dock	1975		1976	
	First	Final	First	Final
Duluth, Minn.: DM&IR -----	Mar. 26	Dec. 20	Apr. 11	Dec. 19
Silver Bay, Minn.: Reserve -----	Apr. 12	Dec. 28	Apr. 1	Jan. 1 ¹
Superior, Wis.: Burlington Northern ----	Apr. 11	Jan. 7 ²	Apr. 9	Dec. 26
Taconite Harbor, Minn.: Erie -----	Mar. 26	Jan. 9 ²	Apr. 4	Dec. 28
Two Harbors, Minn.: DM&IR -----	(³)	(³)	(³)	Jan. 19 ¹

¹ 1977.² 1976.

³ Because of favorable navigation conditions permitting vessel loading to continue without interruption, the ore docks operated by the Duluth, Missabe & Iron Range Railway (DM&IR) at Two Harbors were not closed for the 1974 or 1975 seasons.

Source: Skillings' Mining Review.

The increasing need to ship Minnesota iron ore and low-sulfur western coal created a demand for new and enlarged carriers. Three supercarriers of the 1,000-foot class were in service on the Great Lakes in 1976 with several more on order. The supercarriers in operation in 1976 included the *Presque Isle*, a tug-barge combination leased from Litton Industries by U.S. Steel; the *Stewart J. Cort*, owned by Bethlehem Steel Corp.; and the *James R. Barker*, owned by the Interlake Steamship Division of Pickands Mather & Co. The *Cort* and the *Presque Isle* were placed in service in 1972 and 1973, respectively, and the *Barker* entered service late in 1976. With the recent larger vessels and expansion of older carriers, the average ore cargo size on the Great Lakes increased to 20,346 gross tons during 1976.³ This figure compares with 19,300 gross tons in 1975.

Construction began in August on the Duluth, Missabe & Iron Range Railway's (DM&IR) \$35.5 million pellet storage and shiploading facility at Two Harbors. The new facilities are designed to provide storage space for increased shipments of taconite pellets moving through the port from the Mesabi Range to lower lake steel mills and to accommodate the largest of the new supercarriers plying the Great Lakes. Stockpiling of pellets at the new 2-million-ton-capacity storage area is scheduled to begin upon completion of the yard in December 1977. Major modifications to No. 2 dock of the vessel-loading facility will incorporate the use of conveyor belt systems and shuttle conveyors, designed to enable the pocket-type gravity ore dock to load vessels up to 1,300 feet long and 130 feet in beam. The

largest ore carriers currently permitted on the Great Lakes have an overall length of 1,000 feet, with a beam of 105 feet. The first cargo is expected to be loaded out at the modified dock facilities in June 1978. In addition to the 1,368-foot No. 2 dock, the Two Harbors facility consists of the 1,344-foot No. 1 dock and the 888-foot No. 6 dock. The latter has not operated since 1962 but will be reopened upon completion of the project in 1978.

The courts ruled on several significant issues in the Reserve Mining Co. controversy but did not bring the longstanding environmental conflict to an end. The pollution of both the air and Lake Superior resulting from the discharge of tailings from the mining company's taconite-processing plant at Silver Bay occupied the attention of law courts, government agencies, and individuals for more than 4 years. During 1976, the Federal District court assessed Reserve Mining Co. more than \$1 million in fines for violating the State water discharge permits and ordered the company to pay the entire cost of an emergency program to provide safe drinking water to residents of four North Shore communities. The Corps of Engineers was earlier ordered to provide filtered water and free cartoned drinking water to affected North Shore residents until the communities could complete municipal filtration plants to remove minute asbestiform particles attributed to Reserve. A filtration plant to supply the needs of the City of Duluth was placed in operation near yearend.

³ Great Lakes Commission. Great Lakes News Letter, V. 21, No. 3, January-February 1977, p. 3.

During 1975, Reserve Mining Co. applied for State permits to build a tailings basin at a site designated as Milepost 7, about 4 miles inland from the firm's Silver Bay processing plant. After nearly 10 months of testimony concerning these permits, a State hearing examiner recommended that Reserve be prohibited from depositing the taconite waste at the Milepost 7 site. The two State agencies responsible for issuing the permits, the Department of Natural Resources and the Pollution Control Agency, followed the hearing examiner's recommendation and urged that the company instead seek permits for a different location, a site designated as Milepost 20, which lies roughly midway between Reserve's mine at Babbitt and its processing plant at Silver Bay. Reserve filed an appeal of the agencies' decisions in the Lake County District Court at Two Harbors, but no decision had been reached by yearend.

The most significant decision affecting the Reserve Mining controversy occurred in July when a U.S. District judge ordered the company to halt its discharge of taconite tailings into Lake Superior by midnight, July 7, 1977. The judge concluded that the State of Minnesota and Reserve were unable to agree on an onland disposal site, and his order was later affirmed by the U.S. Eighth Circuit Court of Appeals. Unless the Lake County District Court rules that the State agencies should review the permit applications and grant the necessary permits, Reserve Mining Co. will face a permanent shutdown in mid-1977.

The Twin Cities Metallurgy Research Center of the Federal Bureau of Mines continued a variety of studies to develop new processes and to improve current methods of beneficiating nonmagnetic taconites. Three reports published during the year described results of some of the research regarding using low-rank fuel as reductants in processing⁴ and developing processes for beneficiating nonmagnetic taconites that were not economically amenable to conventional iron beneficiation technology.⁵ The Center also continued its studies to determine the effects of utilization of unmethanated low- and intermediate-Btu gas, such as that obtained in coal gasification, on induration of both oxide and metallized pellets.

Iron and Steel.—North Star Steel Co. produced steel from ferrous scrap in two

electric furnaces at St. Paul. In mid-1976 the company began constructing a \$4 million grinding-ball-manufacturing facility at Duluth. Upon completion of the plant in 1977, the facility will have the capability of producing 40,000 tons of grinding balls annually for use by the expanding taconite industry. Steel will be melted and rolled at North Star's St. Paul plant and shipped as bar stock to the new Duluth plant for induction heating and forging into grinding balls of 1- to 3-inch diameter.

Manganiferous Ore.—With the 1976 reopening of the Algoma-Zeno mine by the Pittsburgh Pacific Co., shipments of manganiferous ore (containing 5% to 35% manganese) from the Cuyuna Range increased 86% to about 202,000 short tons. In addition to the Algoma-Zeno (formerly known as the Lauretta mine), the company operated the Mangan No. 1 mine and completed stockpile shipments from the Louise mine. Pittsburgh Pacific modified the crushing and dry-screening sections of the Virginia plant at Ironton to treat ore from these properties. No other company produced manganiferous ore in Minnesota during the year.

Table 7.—Minnesota: Shipments of manganiferous ores¹ from the Cuyuna Range

	Ferruginous manganese ore (10% to 35% Mn, natural)		
	Quantity (long tons)	Content (natural)	
		Fe (percent)	Mn (percent)
1972 --	106,539	27.09	12.64
1973 --	152,653	27.69	12.59
1974 --	201,393	29.64	12.74
1975 --	97,097	30.83	11.84
1976 --	180,599	27.00	12.80

¹ All manganiferous ores shipped from the Cuyuna Range in 1976 were ferruginous manganese ore containing 10% to 35% manganese. There have been no shipments of manganiferous iron ore containing 5% to 10% manganese since 1969.

⁴ Pahlman, J. E., P. L. Ruzzi, and R. B. Schluter. Roasting Nonmagnetic Taconites in a Fluid Bed Using Low-Rank Fuels as Reductants. BuMines RI 8149, 1976, 15 pp.

Peterson, R. E., and C. Frasky. Metallization of Pelletized, Domestic Iron Oxide Superconcentrates with Lignite and Coal in a Rotary Kiln. BuMines RI 8179, 1976, 18 pp.

⁵ Colombo, A. F., and H. D. Jacobs. Beneficiation of Nonmagnetic Taconites by Selective Flocculation-Cationic Flotation. BuMines RI 8180, 1976, 17 pp.

NONMETALS

Abrasive Stone.—The Jasper Stone Co. produced grinding pebbles and tube-mill liners from a quartzite deposit near Jasper in Rock County in southwestern Minnesota. Although sales of grinding pebbles decreased slightly, combined sales of both products were greater than in 1975.

Cement.—For the first time in decades, no cement was produced in the State. The State's only cement plant, operated by Universal Atlas Cement Div. of United States Steel Corp. at Duluth, was closed at the end of 1975. All raw materials were brought in from outside the State. The sales territory for the plant included North Dakota, South Dakota, northern Minnesota, northern Wisconsin, and Upper Michigan. The company reportedly closed the 63-year-old plant because of product-marketing problems and lack of raw materials. Interest in acquiring and reopening the plant was expressed by Intermix Corp. of White Pine, Mich. If the company purchases the plant and is able to secure environmental permits needed to operate it, Intermix intends to use tailings from copper mined at White Pine, Mich., and Michigan limestone as its raw materials.

Clays.—Common clay and shale were produced by Acolite, Inc., and Ochs Brick & Tile Co. in Brown County and by Aglite, Inc. (formerly North Central Lightweight Aggregate Co.) in Hennepin County. Ochs Brick & Tile Co. also reported production of kaolin from Redwood County. Total clay sales increased nearly 10% in quantity and 20% in value. Most of the output was used for manufacturing concrete block and face brick, with lesser amounts for structural concrete products and other uses.

The Marshall Economic Development Corp. received a grant from the Governor's Rural Development Council to study the feasibility of marketing clay from the numerous small, untapped deposits along the Minnesota River. Test firing of material began in September and continued through yearend to determine the best clay deposits between Granite Falls and Mankato. Further analysis was to be made of the three most promising sites in hopes of developing some type of clay products industry in the area.

Lime.—American Crystal Sugar Co. continued to produce lime for its own use in sugar refining at the following locations: Moorhead in Clay County, Crookston and East Grand Forks in Polk County, and Renville in Renville County. The company imports high-quality lime rock for its plants from Michigan. Output from all four plants increased over that of 1975.

Sand and gravel.—Sand and gravel continued to be the second leading mineral commodity produced in the State, exceeded only by iron ore. Production of construction sand and gravel in 1976 totaled 33.5 million tons, valued at \$44.5 million. Output was reported from 396 locations in 85 counties, Jackson and Traverse Counties being the only counties with no production. Leading counties producing in excess of 1 million tons were Clay, Dakota, Hennepin, St. Louis, and Washington.

Industrial sand was produced in Cook, Le Sueur, and Washington Counties by E. E. Thoreson, Inc., Unisil Corp., and Twin City Silica, Inc. Glass manufacture was the leading consumer of industrial sand, with smaller quantities used for molding, filtration, fillers, and pottery, porcelain, or tile.

Table 8.—Minnesota: Sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Construction sand and gravel:				
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	7,237	14,629	7,511	14,073
Concrete products (cement blocks, bricks, pipe, etc.)	2,391	4,138	3,151	5,863
Asphaltic concrete aggregates and other bituminous mixtures	5,920	7,435	6,855	8,489
Roadbase and coverings	12,555	12,951	10,637	11,589
Fill	4,115	3,079	4,278	3,496
Other uses	¹ 1,178	¹ 2,981	1,054	992
Total construction sand and gravel ²	³ 33,398	³ 45,214	33,486	44,503
Industrial sand	(¹)	(¹)	W	W
Grand total	³ 33,398	³ 45,214	⁴ 33,486	⁴ 44,503

W Withheld to avoid disclosing company proprietary data.

¹ Industrial sand combined with "Other uses" of construction sand and gravel for 1975 to avoid disclosing company proprietary data.

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

³ Includes industrial sand.

⁴ Excludes industrial sand.

Table 9.—Minnesota: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976 ¹		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Aitkin	4	513	673	3	49	61
Anoka	1	W	W	1	311	W
Becker	7	410	578	8	407	433
Beltrami	5	289	321	7	599	852
Benton	3	W	W	1	55	53
Brown	5	419	433	3	119	189
Carleton	5	278	193	3	198	109
Carver	3	326	485	1	W	W
Cass	4	94	194	6	271	581
Chippewa	5	470	395	5	445	371
Chisago	5	190	219	4	169	207
Clay	10	1,089	1,531	10	1,795	2,655
Clearwater	3	181	210	5	343	308
Cook	4	340	466	2	W	W
Cottonwood	4	112	132	5	183	243
Crow Wing	12	219	255	11	232	243
Dakota	16	2,554	3,020	15	2,389	3,138
Dodge	1	33	16	1	33	16
Douglas	3	83	142	5	223	318
Faribault	1	154	408	1	W	W
Fillmore	4	79	169	4	64	113
Freeborn	8	631	997	10	523	753
Goodhue	9	381	416	6	193	235
Hennepin	26	3,578	4,061	22	3,583	3,812
Hubbard	4	124	188	5	143	184
Isanti	1	23	76	1	23	76
Itasca	10	714	1,572	7	589	1,410
Jackson	3	118	127	--	--	--
Kanabec	2	W	W	3	116	179
Kandiyohi	6	649	689	5	660	899
Kittson	2	33	W	3	201	315
Koochiching	8	147	78	7	253	225
Lac qui Parle	2	84	W	2	W	W
Lake	3	79	105	2	W	W
Lake of the Woods	3	341	600	1	50	56
Le Sueur	4	641	2,526	2	W	W
McLeod	4	318	311	3	64	73
Mahnomen	1	68	43	2	W	W
Martin	2	203	249	1	50	60
Meeker	4	205	302	3	74	162
Mille Lacs	4	171	153	3	102	123
Morrison	4	318	662	4	232	552

See footnotes at end of table.

Table 9.—Minnesota: Sand and gravel sold or used by producers, by county—
Continued

(Thousand short tons and thousand dollars)

County	1975			1976 ¹		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Mower -----	6	221	237	3	117	144
Murray -----	4	W	W	2	18	10
Olmsted -----	4	340	509	4	396	514
Otter Tail -----	5	59	55	6	443	682
Pennington -----	1	3	1	2	W	W
Pine -----	3	759	499	3	466	365
Pipestone -----	1	3	1	1	W	W
Polk -----	5	399	598	5	490	569
Pope -----	4	61	81	3	64	96
Red Lake -----	1	207	259	1	114	61
Redwood -----	4	156	112	5	367	338
Renville -----	5	613	634	4	318	394
Rice -----	8	273	518	7	258	343
Rock -----	3	284	672	2	W	W
St. Louis -----	49	3,465	3,802	33	2,448	3,390
Scott -----	5	640	613	4	518	533
Sherburne -----	10	925	1,415	10	991	1,578
Stearns -----	11	688	792	7	638	590
Steele -----	7	707	996	7	550	773
Swift -----	3	262	179	1	126	64
Todd -----	5	742	705	7	772	709
Wabasha -----	3	138	253	3	128	207
Wadena -----	1	17	9	1	19	18
Washington -----	20	2,501	4,511	19	W	W
Watsonwan -----	1	13	12	4	W	W
Wilkin -----	5	114	66	4	133	109
Winona -----	4	321	622	4	387	621
Wright -----	11	448	741	10	335	511
Yellow Medicine -----	4	40	84	5	83	196
Undistributed ² -----	r 32	2,333	3,247	36	8,539	12,692
Total ³ -----	440	33,398	45,214	396	33,486	44,503

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Data for 1976 exclude industrial sand to avoid disclosing company proprietary data.

³ Includes Big Stone, Blue Earth, Grant, Houston, Lincoln, Lyon, Marshall, Nicollet, Nobles, Norman, Ramsey, Roseau, Sibley, Stevens, Traverse (1975), and Waseca Counties, and some sand and gravel that cannot be assigned to specific counties (1976).

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

Stone.—Combined output for all types of crushed or broken and dimension stone increased 10% in quantity and nearly 11% in total value over that of 1975, establishing a record high value for the sixth consecutive year. Granite, limestone (including dolomite), quartzite, and traprock were produced during the year.

Limestone, which comprised 73% in volume and 54% in value of all stone produced in Minnesota during the year, was quarried from deposits in 15 south-central and southeastern counties. Total output of dimension and crushed and broken limestone increased about 10% in quantity and 17% in value over that of 1975. Crushed limestone sales from 86 sites totaled 5.5 million tons valued at \$11.6 million, increases of 10% and 22%, respectively, over the 1975 figures. Dimension limestone was

produced at five quarries in Blue Earth, Le Sueur, and Winona Counties. The output of 14,000 tons, valued at \$2.2 million, from these quarries represented decreases of 22% and 2%, respectively, from 1975 sales.

Granite was quarried by 7 companies from 13 quarries in central Minnesota and in the Upper Minnesota River Valley in west-central Minnesota. Minnesota ranked fourth in the United States in the value of dimension granite produced, preceded by South Dakota, Georgia, and Vermont. Output of dimension granite, which comprises the predominant portion of the value of granite products, decreased slightly, while crushed and broken sales increased 16% in tonnage and 22% in value. The principal use of dimension granite was for buildings and monuments. Although some of the material was sold in rough form, nearly all of

the output was dressed at finishing plants in the State. Minnesota granite is much sought after as an architectural building stone because of its great variety of colors and textures. More than three-fourths of the crushed and broken granite was for use as railroad ballast, with the remainder for various road aggregates, poultry grit, and other uses.

Crushed and broken quartzite was produced by New Ulm Quartzite Quarries, Inc., in Nicollet County. Output increased over

that of 1975. Most of the production from Jasper Stone Co.'s quartzite quarry in Rock County was used in manufacturing grinding pebbles and tube-mill liners; however, a small amount was sold as dimension stone for other uses.

Production of crushed and broken traprock, from three St. Louis County quarries, decreased from that of 1975. Sales were principally for railroad ballast and road aggregates, with lesser amounts sold for riprap and fill.

Table 10.—Minnesota: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Agricultural limestone -----	391	873	598	1,534
Concrete aggregate -----	500	1,192	694	1,732
Bituminous aggregate -----	378	745	498	1,037
Macadam aggregate -----	W	W	92	191
Dense-graded roadbase stone -----	2,317	3,972	2,458	4,612
Surface treatment aggregate -----	761	1,479	708	1,446
Other construction aggregate and roadstone -----	576	1,218	516	1,213
Riprap and jetty stone -----	84	204	103	245
Railroad ballast -----	1,335	2,442	1,478	2,842
Fill -----	3	5	W	W
Bedding material -----	1	2	—	—
Other uses ² -----	466	1,113	395	1,095
Total ³ -----	6,812	13,244	7,530	15,948

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

¹Includes granite, limestone, quartzite, and traprock.

²Includes stone used in asphalt filler, drainfields (1976), filter stone, lime manufacture (1975), mineral food (1975), poultry grit, terrazzo and exposed aggregate (1975), whiting, other miscellaneous uses, and uses indicated by symbol W.

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

Table 11.—Minnesota: Production of dimension stone,¹ by use

Use	1975			1976		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough blocks -----	4,018	47,420	\$209	2,106	24,700	\$126
Cut stone -----	23,150	279,900	7,621	18,150	220,800	6,211
House stone veneer ---	6,217	76,740	410	W	W	W
Dressed monumental -----	5,508	63,950	1,661	8,498	101,400	2,963
Other uses ² -----	3,876	42,050	157	8,246	94,160	518
- Total ³ -----	42,765	510,040	10,058	36,997	441,060	9,819

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

¹Includes granite, limestone, and quartzite.

²Includes sawed stone, flagging (rough and dressed), rubble, rough monumental, irregular-shaped and other stone, and use indicated by symbol W.

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

Table 12.—Minnesota: Crushed limestone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Blue Earth -----	3	W	W	4	522	989
Clay -----	1	3	4	—	—	—
Fillmore -----	12	309	729	11	444	1,118
Goodhue -----	13	248	403	5	71	133
Houston -----	19	371	667	20	440	866
Olmsted -----	9	486	925	10	669	1,452
Scott -----	7	920	1,748	6	1,025	2,128
Steele -----	1	115	217	1	120	278
Wabasha -----	4	W	W	5	146	287
Washington -----	3	572	1,170	5	892	1,948
Winona -----	9	W	W	10	204	416
Undistributed ¹ -----	11	1,980	3,684	9	965	1,993
Total ² -----	92	5,003	9,549	86	5,499	11,608

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

¹ Includes Dakota, Dodge, Le Sueur (1975), Mower, and Rice Counties, and data indicated by symbol W.

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

Sulfur (Recovered Elemental).—Byproduct sulfur was recovered at crude-petroleum-refining operations in Dakota and Washington Counties. Sales increased about 7% in quantity, but the total value of sales decreased 6%.

Vermiculite.—Crude vermiculite mined outside the State was exfoliated at plants operated by W. R. Grace & Co. and Diversified Insulation, Inc., in Hennepin County and by MacArthur Co. in Ramsey County. Sales from the three plants increased 12% in quantity and 27% in value. Approximately three-fourths of the expanded material was used for insulation. The remainder was used for concrete and plaster aggregate, in horticulture and for fireproofing.

MINERAL FUELS

Coke.—United States Steel Corp. and Koppers Co., Inc., produced coke at ovens in Duluth and St. Paul, respectively. Production declined slightly from that of 1975. The two plants carbonized coal from four Southeastern and two Western States in producing metallurgical-grade coke for blast furnace, foundry, and other industrial uses.

Peat.—Production was reported by four companies from operations in Aitkin, Carlton, Itasca, and St. Louis Counties. Sales of peat were nearly double those of 1975, and the increase in total value was even more marked as the average value increased

from \$17.20 to \$56.93 per ton. Moss peat accounted for 82% of the output, and reed-sedge for the remainder. All sales were for general soil improvement use in bulk and packaged form.

The Bay-Houston Towing Co. requested a lease on 19,000 acres of State-owned land in St. Louis County and on an additional 7,000 acres of county land to evaluate the peat for a potential horticultural use. No action was taken by the State during the year.

Although the 26,400 tons of peat produced during 1976 was a record high, that figure may someday appear small if current research results in using peat as an alternative energy source. Peat is being discussed as a source for production of synthetic natural gas, or a direct-burning fuel for electricity-generating plants, and for other uses.

The Minnesota Gas Co. (Minnegasco) received a \$1.2 million grant from the ERDA for initial research on converting peat to pipeline-quality gas. The company has proposed a \$250 million demonstration plant for peat gasification, which would produce 250 million cubic feet of synthetic natural gas daily. Minnegasco's 1975 application to the DNR for the lease of 200,000 acres of State-owned peat lands is still pending while the DNR continues its \$1.25 million study of Minnesota peat resources.

An initial phase of the DNR-directed study will attempt to inventory Minnesota's estimated 7.5 million acres of peat lands.

Other phases will focus on technological assessments and environmental and socio-economic impacts of potential peat developments. All phases of the study will be completed before any leases for large-scale developments are considered. A report prepared by the Midwest Research Institute as part of the DNR-directed program was issued in December. The report was entitled "Environmental Effects and Preliminary Technology Assessment."

In an effort to evaluate the potential of peat as a direct-burning fuel in a powerplant, the Iron Range Resources and Rehabilitation Board (IRR&R), in cooperation with the Midwest Research Institute and the Soil Science Department of the University of Minnesota, filed an application to obtain Federal funds for the project through ERDA. The proposed experiment would be conducted at the Virginia municipal plant, where one of the coal-fired boilers would be converted to burn peat. Interest in the project has been indicated by both the Upper Great Lakes Regional Commission and ERDA. The proposed project would provide for a 2-year demonstration using peat as the fuel for electrical generation and steam heating. In anticipation of approval of this proposal, IRR&R began research to establish new drying and harvesting methods for peat.⁶

It was announced that the Sixth International Peat Congress would be held in Duluth, Minn., in August 1980. It is anticipated that more than 500 international delegates will attend the session, which will address the production and processing of peat and its various use areas, such as horticulture, energy, agriculture, and forestry.

Petroleum Refineries.—Combined crude oil distillation capacity at Minnesota's three refineries at yearend was 217,943 barrels per day. The three refineries and a fourth

at Superior, Wis., provide more than half of the State's requirements of gasoline, fuel oil, and other refined products. Historically, they have been almost totally dependent on Canadian crude oil; however, in an effort to ensure crude for its own domestic needs, Canada has begun to phase out exports, and by the early 1980's, Minnesota refineries will not be receiving any feedstock from Canada.

In studying possible alternate sources of supply, four pipelines have been proposed that could provide a continuing supply of crude oil from anywhere in the world. The proposed projects are—

1. An expansion of the Williams Pipe Line Co. line originating in Kansas and Oklahoma that would involve constructing a 123-mile, 18-inch pipeline from Mason City, Iowa, to the Twin Cities.

2. A new pipeline from south-central Illinois to the Twin Cities that would provide access to foreign crude oil unloaded in Louisiana.

3. A pipeline from the Pacific Coast port of Kitimat, British Columbia, to Edmonton, Alberta, where it would join the Interprovincial-Lakehead pipeline that now brings Canadian crude oil to Minnesota and other Northern States. Although entirely within Canada, the Kitimat line would not transport Canadian oil but is intended for Alaskan oil, and possibly Indonesian or Middle East crude as well, that would be shipped to Kitimat in tankers.

4. A 1,500-mile line has been proposed by Northern Tier Pipeline Co. from Port Angeles, Wash., to Clearbrook, Minn., where it would connect with the Lakehead pipeline to the Twin Cities and Chicago.

Although construction of any of the four lines remains doubtful, the various proposals were being examined.

⁶ Minnesota Iron Range Resources and Rehabilitation Board. Biennial Report, 1974-76. P. 12.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Jasper Stone Co -----	14575 Garden Rd. Golden, Colo. 80401	Quarry and plant	Rock.
Clays:			
Acolite, Inc -----	Box 106 Springfield, Minn. 56087	Pit and plant	Brown.
Aglite, Inc -----	4901 West Medicine Lake Dr. Minneapolis, Minn. 55442	do -----	Hennepin.
Ochs Brick & Tile Co -----	Box 106 Springfield, Minn. 56087	do -----	Brown and Redwood.
Coke:			
Koppers Co., Inc -----	1000 North Hamline Ave. St. Paul, Minn. 55104	Coke ovens	Ramsey.
United States Steel Corp --	Morgan Park Duluth, Minn. 55800	do -----	St. Louis.
Iron ore:			
Cleveland-Cliffs Iron Co.:	1460 Union Commerce Bldg. Cleveland, Ohio 44115		
Canisteo -----		Mine and concentrator.	Itasca.
The Hanna Mining Co.:	100 Erieview Plaza Cleveland, Ohio 44114		
Butler Taconite Project-----		Mine, concentrator, and agglomerator.	Do.
National Steel Pellet Project.		do -----	Itasca and St. Louis.
Whitney -----		Mine and concentrator.	St. Louis.
Carmi -----		Mine; ore treated at Whitney concentrator.	Do.
Jones & Laughlin Steel Corp., Northwest Ore Div.:	Virginia, Minn. 55792 -----		
Hill Annex, Lind- Greenway, and Delaware.		Mines and concentrators.	Itasca.
McKinley and Welton		Mines and concentrator.	St. Louis.
Oglebay-Norton Co.:	1200 Hanna Bldg. Cleveland, Ohio 44115		
Thunderbird -----		Mine -----	Do.
Fairlane plant -----		Concentrator and agglomerator.	Do.
Pickands Mather & Co.:	1100 Superior Ave. Cleveland, Ohio 44114		
Erie Commercial -----		Mine, concentrator, and agglomerator.	Do.
Hibbing Taconite -----		do -----	Do.
Pittsburgh Pacific Co.:	2521 1st Ave. Hibbing, Minn. 55746		
Knox Extension and others.		Mines -----	Do.
Coons Pacific, Julia, and Knox plants.		Concentrators	Do.
Reserve Mining Co.:	Silver Bay, Minn. 55614		
Peter Mitchell -----		Mine and primary crusher.	Do.
Silver Bay plant -----		Concentrator and agglomerator.	Lake.
Rhude & Fryberger, Inc.:	Box 66 Hibbing, Minn. 55746		
Gross-Nelson, Hull-Rust, Leonidas, Pierce, Rana, Sharon-Culver, and Wabigon.		Mines and concentrator.	St. Louis.
Snyder Mining Co.:	Box 730 Buhl, Minn. 55713		
Whiteside -----		Mine and concentrator.	Do.
United States Steel Corp., Minnesota Ore Operations:	Box 417 Mountain Iron, Minn. 55768		
Minntac -----		Mine, concentrator, and agglomerator.	Do.
Plummer group -----		Mine and concentrator.	Itasca.
Rouchleau group -----		do -----	St. Louis.
Sherman group -----		do -----	Do.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Iron and steel:			
North Star Steel Co -----	1678 Red Rock Rd. St. Paul, Minn. 55164	Electric steel furnace.	Ramsey.
Lead smelters (secondary):			
Gopher Smelting & Refining Co.	3385 South Highway 49 St. Paul, Minn. 55111	Processing plant --	Dakota.
NL Industries, Inc -----	3645 Hampshire Ave., South Minneapolis, Minn. 55426	----do -----	Hennepin.
Lime:			
American Crystal Sugar Co.	101 North 3d St. Moorhead, Minn. 56560	Quicklime; shaft kilns.	Clay, Polk, Renville.
Manganiferous ore:			
Pittsburgh Pacific Co.:	2521 1st Ave. Hibbing, Minn. 55746	-----	-----
Algoma-Zeno and Mangan No. 1.	-----	Mines and concentrator.	Crow Wing.
Louise -----	-----	Stockpile shipments	Do.
Peat:			
Michigan Peat -----	Box 66388 Houston, Tex. 77006	Bog; processing plant.	Carlton.
Northern Peat Co -----	Box 416 Grand Rapids, Minn. 55744	----do -----	Aitkin.
Power-O-Peat Co -----	Box 956 Gilbert, Minn. 55741	----do -----	St. Louis.
Petroleum refineries:			
Continental Oil Co -----	Box 8 Wrenshall, Minn. 55797	Refinery -----	Carlton.
Koch Refining Co -----	Box 2302 Wichita, Kans. 67201	----do -----	Dakota.
Northwestern Refining Co., a division of Ashland Oil, Inc.	Drawer 9 St. Paul Park, Minn. 55071	----do -----	Washington.
Sand and gravel:			
Ames Sand & Gravel, Inc --	Box 2702 Fargo, N. Dak. 58102	Pit and plant ----	Clay.
Anderson Aggregate Co ---	6008 Wayzata Blvd. Minneapolis, Minn. 55416	----do -----	Hennepin.
Arsenal Sand & Gravel Co -	Box 2707 New Brighton, Minn. 55112	----do -----	Ramsey.
Barton Contracting Co ----	10800 89th Ave., North Osseo, Minn. 55369	Pits and plants ---	Chisago, Dakota, Hennepin, Scott, Sherburne, Stearns, Washington, Wright.
Duininck Bros. & Gilchrist.	Olivia, Minn. 56277 -----	----do -----	Various.
Fischer Sand & Aggregate, Inc.	County Road 42 Rosemount, Minn. 55068	----do -----	Dakota.
North Star Concrete Co --	Box 167 Mankato, Minn. 56001	----do -----	Blue Earth, Le Sueur, Niccollet.
J. L. Shiely Co -----	1101 North Snelling Ave. St. Paul, Minn. 55108	Pit and plant ----	Washington.
Starry Construction -----	427 South Lake St. Long Prairie, Minn. 56347	Pits and plants ---	Todd.
Ulland Bros., Inc -----	Box 340 Cloquet, Minn. 55720	----do -----	Various.
Do -----	Box 98 Austin, Minn. 55912	Pit and plant ----	Mower.
Unisil Corp -----	Greenwich Office Park 4 Greenwich, Conn. 06830	Pit and plant; industrial sand.	Le Sueur.
Stone:			
Granite:			
Cold Spring Granite Co.	Cold Spring, Minn. 56320 -	Quarries -----	Big stone, Mille Lacs, Renville.
Do -----	-----	Quarries and plant.	Stearns.
The Green Co., Inc ----	200 14th Ave. Granite Falls, Minn. 56241	Quarry and plant --	Yellow Medicine.
Ortonville Stone Co ---	Box 829 Sioux Falls, S. Dak. 57102	----do -----	Big Stone.
J. L. Shiely Co -----	1101 North Snelling Ave. St. Paul, Minn. 55108	----do -----	Stearns.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued:			
Limestone and dolomite:			
Biesanz Stone Co., Inc.	Box 768 Winona, Minn. 55987	Quarry and plant	Winona.
Bryan Rock Products, Inc.	Box 215 Shakopee, Minn. 55379	Quarries and plants	Scott and Washington.
Hector Construction Co., Inc.	Box 410 Caledonia, Minn. 55921	do	Houston and Winona.
Kappers Construction Co.	133 South Broadway Spring Valley, Minn. 55975	do	Fillmore.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577	Quarry and plant	Dakota.
Lundin Construction Co., Inc.	1905 3d Ave. Mankato, Minn. 56001	Quarries and plants	Blue Earth and Steele.
Mankato Aglime & Rock Co.	Box 254 Mankato, Minn. 56001	Quarry and plant	Blue Earth.
Mankato Stone Center, a division of the Babcock Co.	Box 3088 Mankato, Minn. 56001	Quarries and plants	Blue Earth and Le Sueur.
Osmundson Bros.	Adams, Minn. 55909	do	Mower.
Quarve & Anderson Co.	2430 Marion Rd., SE. Rochester, Minn. 55901	do	Dodge, Fillmore, Olmsted, Wabasha, Winona.
River Warren Aggregates, Inc.	Lakeville, Minn. 55044	Quarry and plant	Scott.
Roverud Construction, Inc.	159 West Main St. Spring Grove, Minn. 55974	Quarries and plants	Fillmore and Houston.
J. L. Shiely Co.	1101 North Snelling Ave. St. Paul, Minn. 55108	do	Scott and Washington.
Vetter Stone Co.	Route 5 Mankato, Minn. 56001	do	Blue Earth and Le Sueur.
Quartzite:			
Jasper Stone Co.	Jasper, Minn. 56144	Quarry and plant	Rock.
New Ulm Quartzite Quarries, Inc.	Route 3, Box 75 New Ulm, Minn. 56073	do	Nicollet.
Traprock (basalt):			
Arrowhead Blacktop Co.	Box 6568 Duluth, Minn. 55806	do	St. Louis.
Ulland Bros., Inc.	Box 340 Cloquet, Minn. 55720	do	Do.
Sulfur, recovered elemental:			
Koch Refining Co.	Box 2302 Wichita, Kans. 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, Minn. 55071	do	Washington.
Vermiculite, exfoliated:			
Construction Products Div., W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant	Hennepin.
Diversified Insulation, Inc.	Box 188 Hamel, Minn. 55340	do	Do.
MacArthur Co.	936 Raymond Ave. St. Paul, Minn. 55114	do	Ramsey.

The Mineral Industry of Mississippi

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Mississippi Geological, Economic, and Topographical Survey for collecting information on all minerals except fuels.

By Owen W. Jones¹ and Alvin R. Bicker, Jr.²

In 1976, mineral production in Mississippi was valued at \$450 million, a record high and almost a 10% increase over the 1975 value. Petroleum (crude) and natural gas constituted 84% of the total value. Although production of both petroleum and natural gas was lower than in 1975, average unit values increased 7% for petroleum and 43% for natural gas. Value of

all other mineral production, excluding petroleum and natural gas, increased \$7.9 million and was 12.5% higher than that of 1975.

¹ State Liaison Officer, Bureau of Mines, Jackson, Miss.

² Economic geologist, Mississippi Geological, Economic, and Topographical Survey, Jackson, Miss.

Table 1.—Mineral production in Mississippi¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	1,592	\$10,605	² 1,487	² \$8,849
Lime ----- do	53	1,060	57	1,248
Natural gas ----- million cubic feet	74,845	36,875	70,762	50,241
Petroleum (crude) ----- thousand 42-gallon barrels	46,614	310,346	46,072	328,957
Sand and gravel ----- thousand short tons	14,872	23,098	³ 12,083	³ 20,394
Stone ----- do	1,629	2,730	1,762	2,968
Value of items that cannot be disclosed:				
Cement, clays (ball clay and fuller's earth, 1976), magnesium compounds, natural gas liquids, and sand and gravel (industrial, 1976) -----	XX	25,295	XX	37,205
Total -----	XX	410,009	XX	449,862
Total 1967 constant dollars -----	XX	162,241	XX	^P 161,725

^P Preliminary. XX Not applicable.

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

² Excludes ball clay and fuller's earth; value included with "Value of items that cannot be disclosed."

³ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Mississippi, by county^{1,2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams	\$29,800	\$34,415	Petroleum, sand and gravel, natural gas, natural gas liquids.
Alcorn	W	W	
Amite	W	W	Petroleum, natural gas.
Benton	W	W	Clays.
Bolivar	W	W	Sand and gravel.
Calhoun	W	W	Natural gas.
Carroll	W	W	Sand and gravel, clays.
Chickasaw	W	W	Stone, natural gas.
Clarke	W	66,927	Petroleum, natural gas, natural gas liquids.
Clay	794	1,400	Natural gas, stone, sand and gravel, petroleum.
Copiah	4,724	4,638	Sand and gravel.
Covington	1,229	W	Natural gas, petroleum.
De Soto	W	W	Sand and gravel.
Forrest	2,944	2,690	Sand and gravel, natural gas, petroleum, clays.
Franklin	W	W	Petroleum, natural gas.
George	125	125	Sand and gravel.
Greene	1,333	W	Petroleum, natural gas.
Grenada	W	W	Sand and gravel.
Hancock	384	649	Natural gas, sand and gravel, petroleum.
Harrison	52	22	Sand and gravel.
Hinds	2,620	2,954	Petroleum, clays, natural gas.
Holmes	2,429	2,329	Sand and gravel, petroleum, natural gas.
Humphreys	220	W	Petroleum, natural gas.
Itawamba	W	W	Clays, sand and gravel, natural gas.
Jackson	W	W	Magnesium compounds, lime.
Jasper	61,553	61,329	Petroleum, natural gas, natural gas liquids.
Jefferson	1,046	936	Petroleum, natural gas.
Jefferson Davis	4,835	11,237	Natural gas, petroleum, sand and gravel.
Jones	15,823	17,441	Petroleum, natural gas, clays.
Kemper	W	W	Clays.
Lamar	45,873	45,184	Petroleum, natural gas.
Lauderdale	W	W	Clays.
Lawrence	W	34	Natural gas, petroleum.
Lee	W	W	Clays.
Leflore	W	W	Petroleum.
Lincoln	7,682	7,438	Petroleum, natural gas, clays, sand and gravel.
Lowndes	14,106	17,517	Cement, sand and gravel, stone, clays.
Madison	2,455	2,647	Petroleum, natural gas.
Marion	6,422	7,126	Natural gas, petroleum, sand and gravel.
Marshall	W	W	Clays.
Monroe	6,272	7,796	Clays, natural gas, sand and gravel, petroleum.
Noxubee	744	W	Clays, stone.
Oktibbeha	W	W	Natural gas.
Panola	W	W	Clays, sand and gravel.
Pearl River	254	245	Natural gas, petroleum.
Perry	517	479	Petroleum, sand and gravel, natural gas.
Pike	3,276	3,675	Do.
Prentiss	7	7	Clays.
Quitman	W	W	Do.
Rankin	15,262	16,362	Natural gas, cement, petroleum, stone.
Scott	431	464	Petroleum, natural gas.
Scott	3,042	2,864	Do.
Simpson	11,586	11,891	Petroleum, natural gas, clays, natural gas liquids.
Smith	W	W	Sand and gravel.
Stone	W	W	Clays.
Sunflower	33	10	Sand and gravel.
Tate	W	W	Clays.
Tippah	W	W	Clays.
Tishomingo	W	W	Stone, sand and gravel.
Walthall	9,586	10,215	Natural gas, petroleum, sand and gravel.
Warren	W	W	Cement, sand and gravel, stone.
Washington	W	W	Sand and gravel.
Wayne	29,239	30,807	Petroleum, natural gas, stone.
Wilkinson	7,729	8,404	Petroleum, natural gas.
Winston	W	W	Clays.
Yalobusha	W	W	Sand and gravel.
Yazoo	18,462	22,663	Petroleum, sand and gravel, natural gas.
Undistributed ³	97,124	46,945	
Total ⁴	410,009	449,862	

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

¹The following counties were not listed because no production was reported: Attala, Choctaw, Claiborne, Coahoma, Issaquena, Lafayette, Leake, Montgomery, Neshoba, Newton, Pontotoc, Sharkey, Tallahatchie, Tunica, Union, and Webster.

²The values of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

³Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Mississippi business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands...	904.5	943.0	+4.3
Unemployment ----- do.....	64.6	62.0	-4.0
Employment (nonagricultural):			
Mining ----- do.....	6.5	7.0	+7.7
Manufacturing ----- do.....	201.8	218.5	+8.3
Contract construction ----- do.....	37.5	39.7	+5.9
Transportation and public utilities ----- do.....	34.3	34.6	+0.9
Wholesale and retail trade ----- do.....	134.3	141.4	+5.3
Finance, insurance, real estate ----- do.....	28.0	28.7	+2.5
Services ----- do.....	96.5	101.7	+5.4
Government ----- do.....	153.5	155.8	+1.5
Total nonagricultural employment ----- do.....	¹ 692.3	727.4	+5.1
Personal income:			
Total ----- millions...	\$9,465	\$10,663	+12.7
Per capita ----- do.....	\$4,044	\$4,529	+12.0
Construction activity:			
Number of private and public residential units authorized...	5,235	6,942	+32.6
Value of nonresidential construction ----- millions...	\$73.5	\$105.7	+43.8
Value of State road contract awards ----- do.....	\$97.6	\$125.0	+28.1
Shipments of portland and masonry cement to and within the State ----- thousand short tons...	869	896	+3.1
Mineral production value:			
Total crude mineral value ----- millions...	\$410.0	\$449.9	+9.7
Value per capita, resident population ----- do.....	\$175	\$191	+9.1
Value per square mile ----- do.....	\$8,593	\$9,428	+9.7

^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.

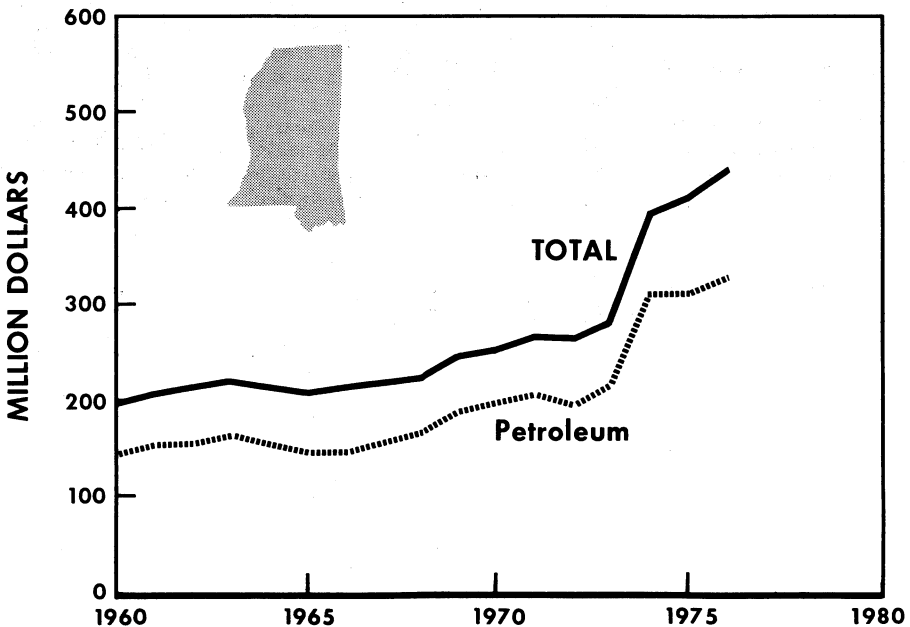


Figure 1.—Value of petroleum and total value of mineral production in Mississippi.

Demand for mineral fuels remained high, and total drilling activity again advanced. Footage drilled increased 4%. The number of exploratory wells drilled was 1% greater than in 1975, and the success ratio was 5% greater. Although the number of exploratory wells drilled was 9% less than in the record year of 1974, the success ratio was 16% compared with 10% in the record year. The exploratory well success ratio has steadily improved in recent years because of more careful screening of drilling prospects.

Energy companies continued to show interest in Mississippi lignite. An estimated 400,000 acres had been leased for lignite prospecting in the 33-county area of east and central Mississippi where the deposits occur. Phillips Co., Tenneco Coal, and Consolidation Coal Co. were among the larger companies leasing lignite land. The deposits extend from the Mississippi-Tennessee border near De Soto and Marshall Counties down through central Mississippi to the Alabama-Mississippi border near Kemper and Lauderdale Counties. The area includes portions of 33 counties and covers approximately 13,000 square miles.

Mississippi Power and Light Co. continued the largest construction project in Mississippi's history, the \$1.9 billion Grand Gulf Nuclear Station near Port Gibson. Work was on schedule. The first of two companion units was approximately 38% complete at yearend. The first unit, with 1,250,000-kilowatt capability, is to be com-

pleted in late 1980, and the second unit is to be completed in 1984.

The electric utility industry continued to be beset by three dominant problems: Inflation, high cost of new capital, and the dwindling and uncertain supply of boiler fuel. In 1976, fuel was available but the cost per kilowatt-hour of electricity increased about 25%.

During 1976, Mississippi Power Co. signed two long-term agreements for the purchase of more than 26 million tons of low-sulfur coal for the Jackson County steam plant starting in 1978. The coal will be transported by rail from Colorado and Utah. This coal will be much more expensive than coal presently being burned, but its use is required to meet environmental standards. Mississippi Power Co. continued construction of the \$317 million Jackson County steam plant near Moss Point-Pascagoula. The first of two 500,000-kilowatt generating units was scheduled for service in mid-1977, and the second was scheduled for 1980. The plant will be oil-fired until late 1978, when coal will become the principal fuel.

Employment.—According to the Mississippi Employment Security Commission, the number of wage and salary workers in petroleum production, refining, and related industries increased 1%. Employment in the mining industry (including oil and gas extraction and nonmetallic mining) was 7,000, an increase of almost 8%, and unemployment was down 4%. Nonagricultural employment statewide increased 5%.

Table 4.—Mississippi: Wage and salary workers in petroleum production, refining, and related industries

Year	Crude petroleum and natural gas production	Petroleum refining ¹	Pipeline transportation (except natural gas)	Gas utilities	Retail filling stations	Chemicals manufactured as byproducts of petroleum or used in refining petroleum ²
1972 -----	5,764	1,038	182	2,225	5,429	397
1973 -----	5,131	1,006	177	2,236	5,766	459
1974 -----	5,295	1,119	170	2,192	5,216	482
1975 -----	5,555	1,270	167	2,219	5,165	523
1976 -----	6,087	1,262	166	2,148	5,203	W

W Withheld to avoid disclosing company proprietary data.

¹ Employment in petroleum refineries and in petrochemical manufacturing facilities located in petroleum refineries.

² Employment in petrochemical manufacturing facilities located outside petroleum refineries.

Source: Mississippi Employment Security Commission.

Legislation and Government Programs.—The Mississippi Legislature began considering legislation to regulate all surface mining. Recent economic and fuel supply developments have made it appear that mining of Mississippi lignite might become economically feasible, and several energy-producing companies conducted lignite exploration programs, resulting in the leasing of several hundred thousand acres of land. As a followup of this activity, the Mississippi Geological, Economic, and Topographical Survey published "An In-

vestigation of the Tertiary Lignites of Mississippi," which discusses the history of lignite mining in Mississippi; the origin and nature of lignite; recent exploration activity; potential uses; and environmental considerations. Included are descriptions of 98 test and core holes drilled in 19 counties.

The Mississippi Marine Resources Council continued development of a coastal resources management program in accordance with the Coastal Zone Management Act of 1972.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The combined value of crude petroleum and natural gas production was \$379 million. This figure was \$32 million, or 9%, greater than that of 1975 and represented 84% of the State's total mineral production value. The leading mineral-fuel-producing counties in descending order were Clarke, Jasper, Lamar, Adams, and Wayne.

Total drilling activity resulted in completion of 467 wells: 108 oil productive, 44 gas productive, and 315 dry holes. Total footage drilled was almost 3.8 million feet for an average depth per well of 8,124 feet, compared with 8,096 feet in 1975. Of the 201 wells drilled in proved fields, 79 were oil productive and 30 were gas productive, a success ratio of 54%. Of the 266 exploratory wells drilled, 29 were oil

productive and 14 were gas productive, a success ratio of 16%. Exploratory drilling accounted for 57% of the total wells drilled.

According to the Mississippi State Oil and Gas Board, 13 gas pools and 36 oil pools were discovered during the year. At yearend there were 478 oil pools and 97 gas pools producing from 487 fields in the State. Producing wells totaled 3,102.

Drilling was largely concentrated in the shallow Wilcox trend of southwestern Mississippi. Drilling for Lower Cretaceous objectives in the central part of the Interior Salt Basin made up the next most active drilling area. High interest in the Lower Cretaceous gas prospects of this area led to intense competition for leases and resulting high acreage and royalty prices.

Table 5.—Mississippi: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Adams	26	1	32	8	--	83	150	920,171
Amite	--	--	1	1	--	3	5	51,764
Claiborne	--	--	--	--	--	1	1	16,508
Clarke	18	--	3	3	--	10	29	229,882
Clay	--	4	1	--	--	--	5	27,730
Copiah	--	--	--	--	--	1	1	18,211
Covington	--	2	2	--	4	3	11	152,824
Forrest	--	--	--	--	--	1	1	8,800
Franklin	6	--	12	4	--	19	41	289,712
George	--	--	--	--	--	1	1	19,183
Greene	1	1	--	1	--	--	3	32,339
Grenada	--	--	--	--	--	1	1	4,022
Hancock	--	2	1	--	--	--	3	29,105
Hinds	1	--	1	1	--	5	8	81,206
Holmes	--	--	--	1	--	2	3	31,269
Issaquena	--	--	--	--	--	1	1	15,212
Itawamba	--	--	1	--	--	1	2	3,641
Jasper	5	--	--	1	--	7	13	165,951
Jefferson	--	1	1	--	1	14	17	116,517
Jefferson Davis	--	7	--	--	4	1	12	183,720
Jones	2	--	3	2	--	2	9	185,307
Kemper	--	--	--	--	--	1	1	2,985
Lamar	4	--	--	--	--	--	4	36,152
Lawrence	--	--	--	--	1	3	4	52,484
Lee	--	--	--	--	--	1	1	2,706
Lincoln	2	--	5	2	--	5	14	160,672
Lowndes	--	5	--	--	--	1	6	35,046
Madison	1	--	--	--	--	--	1	4,457
Marion	--	--	--	--	--	1	1	13,000
Monroe	--	5	3	--	1	5	14	67,369
Pearl River	1	--	--	--	--	--	1	14,064
Perry	2	--	--	--	--	--	2	31,340
Pike	1	--	1	1	--	3	6	69,201
Pontotoc	--	--	--	--	--	1	1	6,650
Rankin	--	--	--	--	1	1	2	32,443
Scott	--	--	--	--	--	1	1	5,220
Sharkey	--	--	--	--	--	1	1	4,210
Simpson	--	--	1	--	--	--	1	13,810
Smith	--	--	--	--	2	1	3	49,397
Walthall	--	2	4	--	--	1	7	84,364
Warren	--	--	--	--	--	1	1	5,053
Washington	--	--	--	--	--	2	2	17,507
Wayne	5	--	2	2	--	2	11	94,662
Wilkinson	4	--	17	2	--	36	59	433,243
Yazoo	5	--	1	--	--	--	6	29,915
Total	79	30	92	29	14	223	467	3,794,024

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Natural Gas.—Production continued the downward trend begun in 1964. Marketed production was 70.8 billion cubic feet (MMMcf) compared with 74.3 MMMcf in 1975. The average price advanced from 49.6 cents per thousand cubic feet (Mcf) to 71 cents per Mcf, causing total value of marketed production to be 36% higher than in 1975.

Of the 37 gas-producing counties, 5 supplied 65% of the natural gas produced in the State. In descending order of production they were Jefferson Davis, Rankin, Walthall, Marion, and Monroe.

According to the American Gas Association (AGA), reserves decreased 146.3

MMMcf, or 12%, during the year. Using AGA statistics, the yearend reserves of 1,061,314 million cubic feet (MMcf) represented a reserve-to-production ratio of 13.3:1 and 0.49% of total U.S. reserves. Field extensions plus new field discoveries plus new reservoir discoveries in old fields added 79.2 MMMcf to the natural gas reserves, but revision of estimates from previous years caused a loss of 134.6 MMMcf, coupled with a decrease in underground storage of 11.0 MMMcf and production (AGA preliminary statistic) of 79.9 MMMcf; this made a total loss of 146.3 MMMcf. Production from gas wells was 73.1 MMMcf; from oil wells it was 16.8

MMMcf. Repressuring used up 5.6 MMMcf, and 13.6 MMMcf was vented and flared. Mississippi consumption of natural gas was 199.6 MMMcf valued at \$209.9 million. The gas consumed in excess of production was from interstate receipts. Of the gas delivered to consumers, 51.4% was to industrial users, 20.0% to electric utilities, and 16.2% to residential users.

Mississippi underground gas storage capacity at yearend was 108 MMMcf. During the year 61.5 MMMcf were withdrawn, while 50.5 MMMcf were put in storage. At yearend there were 257 gas and condensate wells producing in Mississippi.

Exploratory drilling for natural gas was largely concentrated in the Lower Cretaceous near the center of the Mississippi portion of the Interior Salt Basin. The interest in this area was prompted by the 1974 Bassfield gasfield discovery in the Hosston Formation. Several important discoveries were completed in this area during the year.

Natural Gas Liquids.—Reserves of natural gas liquids (NGL) declined 1.4 million barrels (9%) during 1976. Yearend reserve was 13.8 million barrels according to the AGA. Alabama and Mississippi production data are reported as one total figure. Alabama and Mississippi liquefied petroleum gases (LPG) produced at natural gas processing plants totaled 549,000 barrels. Natural gasoline and other products from natural gas processing plants were 296,000 barrels for a total of 845,000 barrels. Ethane, propane, and butane produced at refineries (liquified refinery gases or LRG) totaled 3.9 million barrels for the two States. Mississippi lease condensate production was 743,000 barrels. Alabama lease condensate production was 4.6 million barrels. Yearend stocks at gas processing plants, terminals, and refineries, and in pipelines were 5.6 million barrels.

According to the Oil and Gas Journal annual survey³ of natural gas processing plants, the eight plants operating in Mississippi during 1976 had a total capacity of 852.7 million cubic feet per day; gas throughput averaged 364.2 million cubic feet per day, for an average utilization of 42.8%. Production averaged 130,700 gallons per day. Capacity increased 52%; throughput increased 59%; and utilization increased 2%.

Petroleum.—Production totaled 46 million barrels, a slight decline from that of 1975. Output was valued at \$329 million for an average unit value of \$7.14 per barrel; there was a 7% increase over the average unit value of \$6.66 per barrel in 1975. Ten counties each produced more than 1 million barrels of oil for a total of 41.6 million barrels, or 90% of total production. The 10 counties, in descending order of production, were Clarke, Jasper, Lamar, Adams, Wayne, Yazoo, Jones, Franklin, Smith, and Wilkinson. Average daily production per well in these 10 counties ranged from 87 barrels in Clarke County to 23 barrels in Wilkinson County. Approximately 256 million barrels of salt water was produced in association with crude petroleum production, an average of 5.6 barrels of water per barrel of crude petroleum.

According to API estimates, proved recoverable reserves of crude oil as of December 31, 1976, were 214.2 million barrels, nearly 17 million barrels less than at the end of 1975. According to the Federal Bureau of Mines, crude oil refining capacity of the five Mississippi refineries at the end of 1976 was 331,000 barrels per calendar day, with no new construction underway. Gasoline output capacity was 182,000 barrels per calendar day.

³ Oil and Gas Journal, 1977 Survey of Gas Processing Plants. V. 75, No. 28, July 11, 1977, p. 82.

Table 6.—Mississippi: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Dec. 31, 1975	Changes in proved reserves due to extensions, revisions, and discoveries in 1976	Proved reserves Dec. 31, 1976 (production deducted)	Changes from 1975 (percent)
Crude oil ---- thousand barrels--	231,158	27,585	214,196	- 7.3
Natural gas liquids -----do-----	15,170	137	13,771	- 9.2
Natural gas--million cubic feet--	1,207,627	- 66,437	1,061,314	-12.1

Sources: American Petroleum Institute and American Gas Association.

Table 7.—Mississippi: Crude oil production, indicated demand, and stocks in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand ¹	End-of-month stocks originating in Mississippi
January	3,881	3,827	2,375
February	3,688	3,195	2,867
March	3,946	4,242	2,589
April	3,800	3,845	2,522
May	3,945	3,970	2,495
June	3,769	4,068	2,195
July	3,867	3,872	2,188
August	3,898	4,055	2,029
September	3,746	3,581	2,193
October	3,863	3,566	2,488
November	3,792	3,908	2,376
December	3,877	3,872	2,379
Total:			
1976	46,072	45,996	XX
1975	46,614	46,855	XX

^r Revised. XX Not applicable.

¹ Calculated from monthly production and changes in stocks.

Table 8.—Mississippi: Crude oil production, by field
(Thousand 42-gallon barrels)

Field	1975	1976	Cumulative through Dec. 31, 1976
Baxterville	6,693	6,085	179,820
Bay Springs	1,322	1,364	23,838
Davis	1,349	1,528	9,796
East Eucutta	1,391	1,219	41,765
East Heidelberg	3,372	3,204	84,161
West Heidelberg	1,405	1,271	39,277
West Nancy	942	935	9,478
Pachuta Creek	3,036	3,670	30,945
Quitman Bayou	1,359	1,377	16,896
Tinsley	2,548	2,990	201,501
West Yellow Creek	1,149	1,122	24,638
Other fields	22,048	21,307	925,407
Total	46,614	46,072	1,592,522

^r Revised.

Source: Mississippi State Oil and Gas Board.

Petrochemicals.—Mississippi Chemical Corp. continued construction on 1,150 tons per day of ammonia capacity, 900 tons per day of nitric acid capacity, and 1,200 tons per day of urea capacity to expand its fertilizer manufacturing facilities at Yazoo City. Completion was expected in 1978. The firm produces ammonia in Pascagoula. Chevron Chemical Co. at Pascagoula produces paraxylene from petroleum base stock and ammonia from natural gas feedstock. Conoco Chemicals produces polyvinyl chloride at Aberdeen, and Georgia-Pacific Corp. produces formaldehyde at Taylorsville.

NONMETALS

The combined production value of nonmetals and natural gas liquids was \$70.7 million, a 13% increase over that of 1975, and represented 16% of total mineral production value.

Cement.—Portland and masonry cements were produced at three plants. All three used the wet process. Raw materials consumed were cement rock, limestone, marl, oystershell, clays, sand, and iron ore. Total shipments were up approximately 3%, and total value increased approximately 21%. Ready-mix companies, concrete products manufacturers, and highway contractors were the principal consumers.

Clays.—Total production and value of clays, sold and used, in Mississippi increased over 1975 figures. The four types of clays produced showed increases in both production and value with the exception of

common clay which had an increase in quantity, but a decrease in value.

Clays were mined from 33 pits in 21 counties. Leading counties in descending order of output were Noxubee, Hinds, Monroe, Tippah, and Itawamba. Production from these five counties comprised 67% of the State total. Common clay used for brick, lightweight aggregate, flue lining, drain tile, and sewer pipe was mined in 15 counties. Bentonite was mined in three counties. Fuller's earth was produced in Tippah County, and ball clay was produced in Panola and Quitman Counties.

Lime.—Corchem, Inc., produced quicklime at Pascagoula in Jackson County from dolomite quarried in Alabama.

Magnesium Compounds.—Production of magnesium compounds used in the manufacture of refractory brick increased 13%; value increased 35% from that in 1975.

Perlite.—Johns-Manville Perlite Corp. continued to produce expanded perlite near Natchez in Adams County. The entire output was used to manufacture roof insulation board.

Sand and Gravel.—Production was reported by 57 companies from 66 pits located in 29 counties. Output was approximately 12 million tons, a decrease of approximately 16% from that of 1975. The unit price increased from \$1.61 per ton to \$1.69 per ton.

The leading producing counties in descending order of output were Copiah with 2.6 million tons, Lowndes with 2.0 million tons, Forrest, Pike, and Holmes.

Table 9.—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
1972 -----	278	3,388	144	2,943	1,497	1,506	1,919	7,837
1973 -----	286	3,607	168	3,390	1,623	2,085	2,075	9,082
1974 -----	334	4,599	187	3,822	1,492	2,047	2,013	10,468
1975 -----	264	4,607	176	4,024	1,152	1,975	1,592	10,605
1976 -----	373	6,740	W	W	1,114	2,110	1,487	8,849

W Withheld to avoid disclosing company proprietary data.

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

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

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	4,443	\$5,303	\$1.19
Gravel	7,590	15,092	1.99
Total	12,033	20,394	1.69
Industrial sand	W	W	W
Grand total	W	W	W

W Withheld to avoid disclosing company proprietary data.

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

Table 11.—Mississippi: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, high-ways, bridges, dams, waterworks, airports, etc.)	3,889	\$7,464	\$1.92
Concrete products (cement blocks, bricks, pipe, etc.)	609	1,434	2.35
Asphaltic concrete aggregates and other bituminous mixtures	2,871	5,402	1.88
Roadbase and coverings	4,215	5,611	1.33
Fill	411	470	1.14
Other uses	36	17	.47
Total ¹	12,033	20,394	1.69

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

Stone.—Seven companies crushed stone for cement, agricultural limestone, surface treatment aggregate, and other uses. Output increased 8% to 1,762,000 tons valued at \$2,968,000. Leading producers were United Cement Co., a division of Texas Industries, Inc., Marquette Cement Manufacturing Co., and Mississippi Stone Co., Inc. Among the 50 States Mississippi ranked

third in output of marl.

Sulfur.—Recovery of sulfur from refinery and natural gases was reported from four operations in Rankin, Jackson, Lamar, and Clarke Counties (descending order of production). Mississippi ranked fourth in quantity and third in value among the States. Production decreased 25% and value decreased 16% from the 1975 figures.

Table 12.—Principal producers

Commodity and company	Address	Type of activity or producing field	County
Cement:			
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Plant -----	Rankin.
United Cement Co -----	Box 185 Artesia, Miss. 39736	----do -----	Lowndes.
Valley Cement Industries, Inc.	Box 22491 Jackson, Miss. 39205	----do -----	Warren.
Clays:			
Atlas Brick Co -----	Box 67 Shuqualak, Miss. 39361	3 mines -----	Noxubee.
Delta-Macon Brick & Tile Co., Inc.	RFD 3, Box 2 Macon, Miss. 39341	Mine and plant ---	Do.
Filtrol Corp -----	3250 East Washington Blvd. Los Angeles, Calif. 99023	----do -----	Itawamba and Smith.
Holly Springs Brick & Tile Co., Inc.	Box 310 Holly Springs, Miss. 38635	----do -----	Marshall.
International Minerals & Chemical Corp.	Box 346A Aberdeen, Miss. 39730	Mine -----	Monroe.
Jackson Ready Mix Concrete, a division of Delta Industries, Inc.	Box 1292 Jackson, Miss. 39205	----do -----	Hinds.
Tri-State Brick & Tile Co., Inc.	Box 9787 Jackson, Miss. 39206	Mine and plant ---	Do.
Lime:			
Corchem, Inc -----	Box 1707 Pascagoula, Miss. 39567	Plant -----	Jackson.
Magnesium compounds:			
Corhart Refractories Co ---	1600 West Lee St. Louisville, Ky. 40210	----do -----	Do.
Petroleum (crude) and natural gas:			
Amoco Production Co -----	Box 591 Tulsa, Okla. 74102	Clear Springs -----	Franklin.
		Collins -----	Covington.
		Dollar Lake -----	Lefflore.
		Dry Bayou -----	Franklin.
		North Freewoods ---	Do.
		Knoxville -----	Do.
		North Knoxville ---	Do.
		Quitman Bayou ---	Adams.
		Stringer -----	Jasper.
		Zeigler Creek -----	Franklin.
		East Heidelberg ---	Jasper.
Atlantic Richfield Co -----	Box 2819 Dallas, Tex. 75221	Brookhaven -----	Lincoln.
Chevron Oil Co., Western Div.	Box 599 Denver, Colo. 80201	South Center Ridge. Cranfield -----	Smith. Adams and Franklin.
		Hub -----	Marion.
		Hub East -----	Do.
		Knoxo -----	Walthall.
		East Mallalieu ---	Lincoln.
		West Mallalieu ---	Do.
		Mize -----	Smith.
		Pisgah -----	Rankin.
		Puckett -----	Rankin and Smith.
		Raleigh -----	Simpson.
		Reedy Creek -----	Jones.
		Hazlit Creek -----	Wilkinson.
		North Mud Creek -	Do.
		Davis -----	Clarke.
Cities Service Oil Co -----	Box 12026 Jackson, Miss. 39211	Baxterville -----	Lamar and Marion.
Continental Oil Co -----	Box 2197 Houston, Tex. 77001	Bryan -----	Jasper and Jones.
Exxon Co. U.S.A. -----	Box 2180 Houston, Tex. 77001	East Fairview ---	Adams.
		Gillsburg -----	Amite.
		Gwinville -----	Jefferson Davis.
		Hub -----	Marion.
		Hub East -----	Do.
		Knoxo -----	Walthall.
		Pistol Ridge -----	Pearl River.
		Sandy Hook -----	Marion.
		East Yellow Creek	Wayne.
		North Carthage Point.	Adams.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity or producing field	County
Petroleum (crude) and natural gas—Continued			
Exxon Co. U.S.A.—Continued			
Getty Oil Co -----	Box 1404 Houston, Tex. 77001	Clear Springs -----	Franklin.
Gulf Oil Corp -----	Box 1166 Pittsburgh, Pa. 15220	Courtland -----	Adams.
		Dexter -----	Walthall.
		East Nancy -----	Clarke.
		West Nancy -----	Do.
		Baxterville -----	Lamar and Marion.
		Bolton -----	Hinds.
		Gwinville -----	Jefferson Davis.
		Heidelberg -----	Jasper.
		East Heidelberg -----	Do.
		West Heidelberg -----	Do.
		Pistol Ridge -----	Forrest and Pearl River.
		Soso -----	Jasper, Jones, Smith.
		East Yellow Creek -----	Wayne.
		Tinsley -----	Yazoo.
Pennzoil Producing Co ----	900 Southwest Tower Houston, Tex. 77002	Nancy -----	Clarke.
Placid Oil Co -----	1401 Elm St. Dallas, Tex. 75202	Pachuta Creek -----	Do.
Shell Oil Co -----	Shell Bldg. 921 Common New Orleans, La. 70112	Goodwater -----	Do.
		Bay Springs -----	Jasper.
		Tallahala Creek -----	Smith.
		East Tallahala Creek -----	Do.
Skelly Oil Co -----	Box 1650 Tulsa, Okla. 74101	Bay Springs -----	Jasper.
Sun Oil Co -----	1608 Walnut St. Philadelphia, Pa. 19103	Goodwater -----	Clarke.
		Baxterville -----	Lamar.
		Diamond -----	Wayne.
		West Eucutta -----	Do.
		East Franklin -----	Franklin.
		East Heidelberg -----	Jasper.
		Kokomo -----	Walthall.
		Mantua -----	Adams.
		McComb -----	Pike.
		Mercer -----	Adams.
		Pistol Ridge -----	Forrest and Pearl River.
		Sandy Hook -----	Marion.
		Smithdale -----	Amite.
		Tom Branch -----	Franklin.
		West Yellow Creek -----	Wayne.
		Baxterville -----	Lamar.
		Pachuta Creek -----	Clarke.
Texaco, Inc -----	Box 60252 New Orleans, La. 70150	Purvis refinery ----	Calhoun.
Petroleum refineries:			
Amerada Hess Corp., Hess Oil & Chemical Div.	One Hess Plaza Woodbridge, N.J. 07095	Sandersville refinery.	Jones.
Southland Oil Co -----	Box 328 Yazoo City, Miss. 39194	Lumberton refinery.	Lamar.
		Crupp refinery ----	Yazoo.
		Pascagoula refinery.	Jackson.
Standard Oil Co. of Kentucky.	Box 1300 Pascagoula, Miss. 39567	Stationary -----	Forrest.
Sand and gravel:			
American Sand & Gravel Co.	Box 272 Hattiesburg, Miss. 39401	-----do -----	Copiah.
Blain Sand & Gravel Co --	Box 268 Crystal Springs, Miss. 39059	Portable -----	Monroe.
Contractors Gravel Co ----	Box 2069 Columbus, Miss. 39701	Stationary -----	Carroll.
J. J. Ferguson Sand & Gravel Co.	Box 318 Greenwood, Miss. 38930	-----do -----	Copiah.
Green Bros. Gravel Co., Inc.	Route 4, Box 17 Franklinton, La. 70438	-----do -----	Holmes.
Hammett Gravel Co -----	Box 207 Lexington, Miss. 39095	-----do -----	Warren.
W. J. Runyon & Son, Inc --	3312 Oak St. Vicksburg, Miss. 39180	-----do -----	Adams.
St. Catherine Gravel Co ---	Box 928 Natchez, Miss. 39120	Stationary and dredge.	Copiah.
Traxler Gravel Co., a divi- sion of Delta Industries, Inc.	Box 1292 Jackson, Miss. 39205		

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity or producing field	County
Sand and gravel—Continued			
Warren Bros. Co -----	Box 5336 Greenville, Miss. 38701	Stationary -----	Washington.
Stone:			
Marquette Cement Manufacturing Co.	20 North Wacker Dr. Chicago, Ill. 60606	Quarry -----	Rankin.
Mississippi Stone Co., Inc --	Box 306 Iuka, Miss. 38852	----do -----	Tishomingo.
United Cement Co., a divi- sion of Texas Industries, Inc.	Box 185 Artesia, Miss. 39736	----do -----	Lowndes.

The Mineral Industry of Missouri

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Missouri Geological Survey for collecting information on all minerals.

By Waldemar M. Dressel¹ and James A. Martin²

The value of Missouri's mineral output in 1976 reached \$785 million, an alltime high for the 15th consecutive year. Much of the increase in value can be attributed to higher unit prices, although gains in quantity produced were also recorded for cement, coal, lime, sand and gravel, stone, and zinc. Barite production decreased in both volume and value.

Lead mining continued at a reduced rate for the second straight year, but higher lead prices resulted in an increase in total value. The ASARCO, Inc., smelter at Glover remained on strike during the last 4 months of the year, resulting in a considerable tonnage of lead concentrate being shipped from the State for smelting.

Zinc production increased to 83,530 tons as Missouri regained first place in zinc production, slightly above that produced in Tennessee. Zinc concentrates stockpiled at

one mine early in the year began to move in the fourth quarter with the settlement of a smelter strike in Oklahoma.

Principal minerals produced, in order of value, were lead, cement, stone, iron, zinc, coal, lime, and sand and gravel.

The value of mineral industry output in Missouri exceeds \$1 billion when the value of mineral-processing industry is included with the Federal Bureau of Mines standard raw mineral values. The value added through the conversion of coal and other mineral fuels to electricity, and the processing of alumina to metal, and scrap and pig iron to steel, exceeds the total value of the minerals mined within the State.

¹State Liaison Officer, Bureau of Mines, Rolla, Mo.

²Geologist and chief, Mineral Resources Section, Department of Natural Resources, Division of Geology and Land Survey, Rolla, Mo. (formerly Missouri Geological Survey).

Table 1.—Mineral production in Missouri¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite ----- thousand short tons..	171	\$3,989	124	\$3,860
Cement:				
Masonry ----- do	65	2,110	76	2,718
Portland ----- do	3,962	116,260	4,353	142,976
Clays ----- do	² 2,168	² 13,214	2,133	14,915
Coal (bituminous) ----- do	5,638	48,054	6,075	56,934
Copper (recoverable content of ores, etc.) short tons..	14,258	18,308	11,050	15,382
Iron ore (usable) thousand long tons, gross weight..	2,273	W	2,133	W
Lead (recoverable content of ores, etc.) short tons..	515,958	221,862	500,991	231,458
Lime ----- thousand short tons..	1,606	40,630	1,731	49,907
Natural gas ----- million cubic feet..	30	10	29	10
Petroleum (crude) ----- thousand 42-gallon barrels..	57	W	61	W
Phosphate rock ----- thousand short tons..	35	W	W	W
Sand and gravel ----- do	9,752	18,216	15,375	26,550
Silver (recoverable content of ores, etc.) thousand troy ounces..	2,525	11,161	2,277	9,905
Stone ----- thousand short tons..	46,988	95,535	47,546	98,327
Zinc (recoverable content of ores, etc.) short tons..	74,867	58,396	83,530	61,812
Value of items that cannot be disclosed:				
Asphalt (native), clays (fuller's earth and kaolin, 1975), and values indicated by symbol W -----	XX	74,983	XX	70,406
Total -----	XX	722,728	XX	785,160
Total 1967 constant dollars -----	XX	285,983	XX	² 282,265

¹ Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

² Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

³ Excludes fuller's earth and kaolin; included with "Value of items that cannot be disclosed."

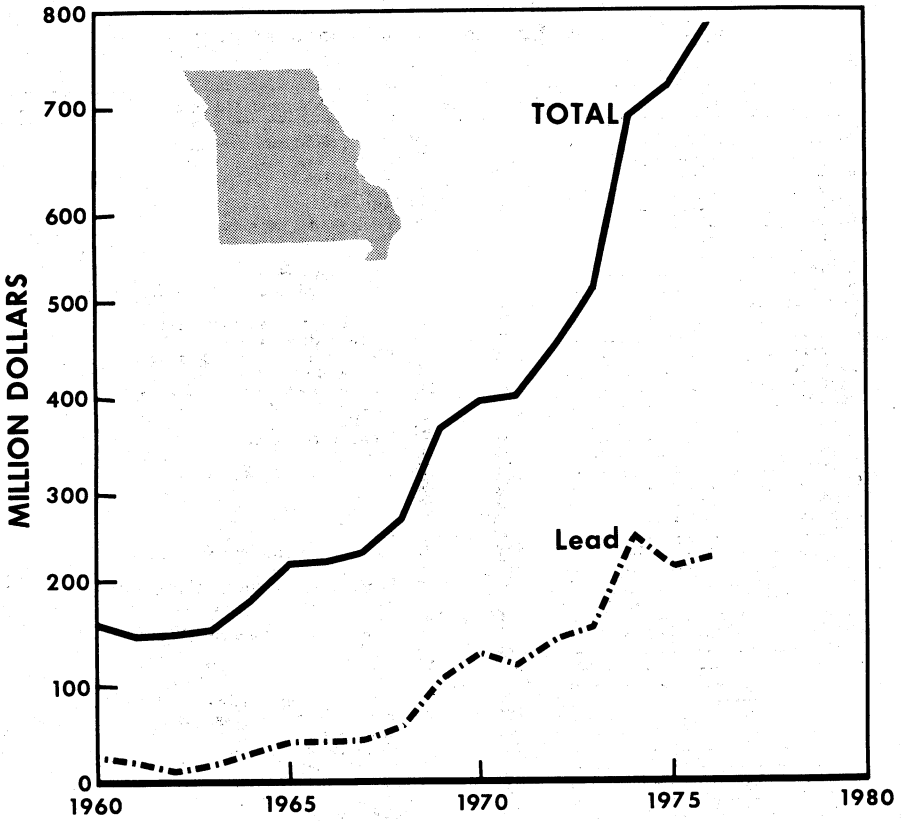


Figure 1.—Value of lead and total value of mineral production in Missouri.

Table 2.—Value of mineral production in Missouri, by county^{1,2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adair	---	W	Stone, sand and gravel.
Andrew	---	W	Stone.
Atchison	---	W	Petroleum.
Audrain	\$3,013	\$2,626	Clays.
Barry	---	514	Stone.
Barton	---	W	Coal, stone, asphalt.
Bates	---	W	Coal, stone.
Benton	---	W	Stone.
Bollinger	---	W	Sand and gravel.
Boone	---	W	Stone, sand and gravel, clays.
Buchanan	---	W	Stone.
Butler	---	W	Sand and gravel, stone, clays.
Caldwell	---	W	Stone, natural gas.
Callaway	---	3,552	Clays, stone, sand and gravel.
Camden	---	W	Sand and gravel, stone.
Cape Girardeau	10,669	13,306	Cement, stone, sand and gravel, clays.
Carroll	---	W	Sand and gravel.
Carter	---	30	Do.
Cass	---	W	Stone, petroleum.
Cedar	---	W	Stone.
Chariton	---	W	Stone, sand and gravel.
Christian	---	W	Do.
Clark	---	W	Do.
Clay	5,201	4,213	Do.
Clinton	---	391	Stone.
Cole	---	W	Stone, sand and gravel.
Cooper	---	W	Do.
Crawford	---	W	Lead, copper, zinc, stone, sand and gravel, silver, clays.
Dade	412	505	Stone.
Dallas	---	W	Stone, sand and gravel.
Daviness	1,765	W	Do.
De Kalb	274	W	Stone.
Dent	---	12	Do.
Douglas	---	453	Sand and gravel, stone.
Franklin	827	W	Sand and gravel, clays, stone.
Gasconade	4,991	W	Clays, stone.
Gentry	475	W	Stone, sand and gravel.
Greene	---	W	Lime, stone.
Grundy	---	W	Stone, sand and gravel.
Harrison	---	W	Do.
Henry	---	W	Coal, stone.
Hickory	96	W	Stone.
Holt	---	W	Do.
Howard	---	W	Stone, coal, sand and gravel.
Howell	---	W	Stone, sand and gravel.
Iron	---	W	Lead, zinc, iron ore, copper, silver, stone, sand and gravel.
Jackson	---	W	Cement, stone, sand and gravel, petroleum.
Jasper	---	W	Stone, sand and gravel.
Jefferson	---	W	Cement, stone, sand and gravel, clays.
Johnson	564	554	Stone.
Knox	---	W	Do.
Laclede	253	W	Do.
Lafayette	---	W	Stone, sand and gravel.
Lawrence	---	W	Stone.
Lewis	---	W	Stone, sand and gravel.
Lincoln	---	W	Do.
Livingston	---	W	Stone, clays, sand and gravel.
McDonald	---	W	Stone.
Macon	---	W	Coal, sand and gravel.
Madison	---	W	Stone, sand and gravel.
Maries	---	W	Clays, sand and gravel.
Marion	---	W	Stone, sand and gravel.
Mercer	---	W	Do.
Miller	348	W	Sand and gravel, stone.
Moniteau	59	W	Stone.
Monroe	---	W	Stone, clays.
Montgomery	---	W	Clays, stone, sand and gravel.
Morgan	---	W	Stone.
Newton	---	W	Do.
Nodaway	---	W	Do.
Oregon	---	W	Sand and gravel, stone.
Osage	---	W	Clays, stone.
Ozark	---	W	Sand and gravel.
Pemiscot	242	341	Do.
Perry	---	W	Stone, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Missouri, by county ^{1 2}—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Pettis -----	W	W	Stone.
Phelps -----	\$368	W	Stone, sand and gravel.
Pike -----	W	W	Cement, stone, clays, sand and gravel.
Platte -----	W	\$3,353	Sand and gravel, stone.
Polk -----	342	189	Stone.
Pulaski -----	640	916	Sand and gravel, stone.
Putnam -----	W	W	Coal, stone.
Ralls -----	W	W	Cement, stone, clays.
Randolph -----	W	W	Coal, stone.
Ray -----	1,920	W	Stone, sand and gravel.
Reynolds -----	W	W	Lead, zinc, copper, silver, sand and gravel, stone.
Ripley -----	W	279	Sand and gravel.
St. Charles -----	3,204	W	Stone, sand and gravel, clays.
St. Clair -----	W	W	Stone.
Ste. Genevieve -----	W	W	Lime, stone, sand and gravel.
St. Francois -----	W	W	Lime, stone.
St. Louis -----	W	44,813	Cement, stone, sand and gravel, clays, petroleum.
St. Louis City -----	--	407	Sand and gravel.
Saline -----	2,574	1,944	Stone.
Scotland -----	W	W	Do.
Scott -----	W	W	Stone, sand and gravel.
Shannon -----	W	117	Stone.
Shelby -----	W	W	Do.
Stoddard -----	750	776	Sand and gravel.
Stone -----	W	W	Stone, sand and gravel.
Taney -----	W	W	Sand and gravel, stone.
Texas -----	W	W	Do.
Vernon -----	W	W	Coal, stone, petroleum.
Warren -----	W	W	Clays, stone, sand and gravel.
Washington -----	80,060	78,131	Iron ore, lead, barite, copper, zinc, silver, phosphate rock.
Wayne -----	W	3,148	Stone, sand and gravel.
Webster -----	181	32	Stone.
Worth -----	W	W	Do.
Wright -----	W	W	Do.
Undistributed ³ -----	608,495	624,553	
Total -----	⁴ 722,728	785,160	

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

¹ The following counties are not listed because no production was reported: Dunklin, Linn, Mississippi, New Madrid, Schuyler, and Sullivan.

² Value of petroleum is based on an average price per barrel for the State.

³ Includes value of stone 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.

Table 3.—Indicators of Missouri business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands	2,071	2,126	+2.7
Unemployment ----- do	142	133	-6.3
Employment (nonagricultural):			
Mining ----- do	8.5	8.2	-3.5
Manufacturing ----- do	399.8	416.4	+4.2
Contract construction ----- do	67.4	68.1	+1.0
Transportation and public utilities ----- do	121.7	123.2	+1.2
Wholesale and retail trade ----- do	406.4	409.2	+0.7
Finance, insurance, real estate ----- do	93.2	93.5	+0.3
Services ----- do	305.7	313.2	+2.5
Government ----- do	315.3	315.6	+0.1
Total nonagricultural employment ----- do	1,718.5	1,747.4	+1.7
Personal income:			
Total ----- millions	\$26,023	\$28,494	+9.5
Per capita ----- do	\$5,459	\$5,963	+9.2
Construction activity:			
Number of private and public residential units authorized	16,135	22,749	+41.0
Value of nonresidential construction ----- millions	\$412.3	\$334.4	-18.9
Value of State road contract awards ----- do	\$220	\$240	+9.1
Shipments of portland and masonry cement to and within the State ----- thousand short tons	1,674	1,773	+5.9
Mineral production value:			
Total crude mineral value ----- millions	\$722.7	\$785.2	+8.6
Value per capita, resident population ----- do	\$152	\$164	+7.9
Value per square mile ----- do	\$10,371	\$11,267	+8.6

^P Preliminary.

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

Labor, Employment, and Safety.—According to the Division of Employment Security, Missouri Department of Labor and Industrial Relations, the mining industry employed 8,179 workers in 1976 compared with 8,512 in 1975. Employment in the coal industry increased to 1,442 compared with 1,385 in the previous year. Employment in the metal mining industry increased to 3,136 compared with 3,108 in the previous year, and the nonmetal industry employed 3,423 in 1976 compared with 3,840 in 1975. A total of 178 workers were employed by the crude petroleum and natural gas industry.

The Mining Enforcement and Safety Administration (MESA) and the Missouri Division of Labor Standards, Inspection Section, Mining, reported that two fatal accidents occurred in Missouri mines during 1976. One fatality resulted from a roof fall in an underground lead mine and one from a surface haulage accident at a limestone operation.

Safety awards were presented at the Annual Meeting of the Missouri Mining Industry Council by the Missouri Division of Labor Standards to Cominco American's Magmont mine, St. Joe Minerals' Fletcher

mine. Ozark Mining Company's Sweetwater mine; Missouri Mining Company, and Peabody Coal Company's Reliance Shop. Meramec Mining Co. received the award for the most improved safety program for the second year in a row.

The Missouri Limestone Producers Association (MLPA) presented a record number of safety awards in 1976 to 30 limestone operations. Recipients of these awards included the following: Big Spring Quarries; Galloway Limestone Co.; Graystone Quarry Co.; Griesemer Stone Co.; Hall and Riley Quarries & Construction Co.; Hilty Quarries, Inc.; Joplin Stone Co.; Joerling Brothers Quarry; Jeff-Cole Quarries; Kelly Lime and Rock Co.; Magnesium Mining Co.; Martin-Marietta Aggregates; Martinsburg Limestone Co.; Midwest PreCote Co.; Mo-Con, Inc.; Morgans Material, Inc.; Orrick Stone; Raid Quarries plants (Mount Moriah, Berlin, Gallatin, Route C, Bethany, Ridgeway, and Breckenridge); Rock Hill Quarries; Rush Quarries, Inc.; Steva Stone; Trager Quarries; Union Quarries; and Williams Rock Co. (Quarles plant).

The Superintendents Safety Competition, to recognize those superintendents doing the most to promote safety, brought wide

response. Over 40 superintendents competed and the top 3 winners received paid vacations.

Portland Cement Safety Awards were presented to Marquette Cement Manufacturing Co.'s Cape Girardeau plant and Universal Atlas Cement's Hannibal plant for 24 and 23 years of operation, respectively, without a disabling injury.

Legislation and Government Programs.—Environment.—Environmental concerns plagued several Missouri mineral industries. In the St. Louis area, emissions from Missouri Portland Cement Co., NL Industries, Inc.'s titanium plant, and Great Lakes Carbon Co. were listed by the Missouri Air Conservation Commission (MACC) as major polluters.

Coal-burning utilities continued to receive variances from the State because they were not able to meet the State's primary air-quality standards, which are stricter than Federal Environmental Protection Agency (EPA) standards.

The public utility company of the City of Columbia was sued by the MACC and enjoined to restrict its use of high-sulfur coals in compliance with State air-quality regulations.

Noranda Aluminum, Inc., requested and received a permit to exceed State air-quality standards at its New Madrid aluminum reduction plant. Air-pollution controls designed to meet the State standard would have cost about \$9 million.

The oil industry was expected to spend about \$7.3 million for pollution controls that prevent vapors from escaping into the atmosphere.

Waste-disposal areas in the St. Louis area, where uranium-processing plants were operated in the 1940's and 1950's, were being checked for radioactive contamination levels. No evidence of a health hazard was shown to exist, but reportedly, a study showed that it would be technically and economically feasible to recycle 6 million cubic yards of sludge from pits on the Weldon Springs property to recover 150 tons of uranium and 75 tons of thorium.

Water in wells and in the Center, Shoal, Turkey, Short, Hickory, and Grove Creeks, and Spring River watershed of the Joplin area were being checked for possible heavy-metal contamination from abandoned mines and tailings-pile runoffs. The work was

performed by the U.S. Geological Survey (USGS) under an EPA water-pollution-control program grant. Following completion of the testing, methods will be developed for correcting any water problems discovered.

Representatives of the mining industry worked with the Missouri Department of Natural Resources to establish a statewide 208 Water Pollution Control Plan.

Peabody Coal Co. challenged the EPA water quality guidelines claiming that the new rules would increase its pollution-control costs by \$60 million during the next decade. The company claimed that (1) the rules failed to differentiate among various areas of the country, (2) requirements for monitoring discharge of iron and manganese were too broad and costly, and (3) that EPA failed to take into account that pollution facilities must be either portable or disposable because mine sites are often moved.

Under Missouri's Environment Improvement Authority, tax-free, low-interest-rate bonds can be issued to help provide low-cost financing for pollution-control equipment. Since December 15, 1973, sales of these bonds have totaled \$70 million, to aid St. Joe Minerals Corp., Armco Steel, Alpha Portland Cement Co., Noranda Aluminum, Inc., and Union Electric Co.

Dam safety legislation, which would include control of tailings dams, was again introduced in the State Legislature, but failed despite the warning from the DNR Division of Geology and Land Survey, that over 200 dams are potentially dangerous and that several imminently hazardous ones exist. Discussions were held with representatives of the State Legislature, State geologist's office, State attorney general's office, Missouri Farm Bureau, and Missouri Mining Industry Council to draft a bill which could be presented to the 1977 legislative session.

The Missouri DNR began an inventory of all Missouri land areas affected by mining to determine location, area, extent, and type of disturbance. The information, which will be available for use in planning future orphan land reclamation programs, is being obtained by a search of records for old mine and quarry locations, from knowledge of existing mines, and by applying remote-sensing techniques.

Table 4.—Missouri: Summary of acreages permitted in 1975 and 1976, by commodity

Commodity	Acreage	
	1975	1976
Barite -----	178	88
Clay -----	84	87
Coal -----	2,018	2,487
Limestone -----	358	459
Sand and gravel -----	48	30
Total -----	2,686	3,151

Surface mining permits were issued for 3,151 acres and renewed for 2,506 acres. Over 58% of the permitted acreage was for coal mining; 30%, for limestone mining; and the remainder, for clay, sand and gravel, and barite mining. Reclamation was completed on 450 acres. Barite producers reclaimed more acreage than they permitted.

Wilderness area proposals, the Meramec dam, and proposed sand-dredging operations highlighted land-use conflicts.

A proposal to establish several wilderness areas on Federal land within the State has been received favorably by environmentalists and outdoor recreationists and unfavorably by the timber industry, the mining industry, and local private landowners. The mining industry wants the area open for mineral prospecting and mining under existing Federal rules and regulations if the results of prospecting are favorable.

On October 19, President Ford signed a wilderness bill that designated four areas as wilderness study areas and gave wilderness status to the 8,000-acre Mingo Wilderness in Wayne and Stoddard Counties and the 12,315-acre Hercules Glade Wilderness in Taney County. The 18,000-acre Irish Wilderness was not included in the legislation because the area may have mining potential. This debate is continuing.

The Meramec River dam debate intensified during the year, with pronouncements from both sides of the argument. Construction of the dam would have minimal effect on the mineral resource potential of the area, although construction developments could have an economic impact on the State's mineral industry.

A proposed sand-and-gravel-dredging operation in the St. Louis area was the subject of controversy. After much study, the St. Louis County Planning Commission granted a conditional permit to allow

Alpha Portland Cement Co. to operate a sand-and-gravel-dredging operation in the Meramec River Valley. Conditions of the mineral permit prohibited Alpha from mining within 300 feet of the river or any other boundary of the property. It specified time of day and days of week during which mining could be conducted, applied strict noise control measures to be taken, and prohibited blasting and dumping of material into the river. The issuance of the conditional permit was challenged by environmental groups, local citizens, and the State Director of Natural Resources. The challenge was in litigation at yearend.

Legislation and Government Programs.—An evaluation of the mineral potential of the Rolla 2° Quadrangle was begun by USGS and the Missouri Division of Geology and Land Survey. These agencies were also involved in a study to analyze the geological, geophysical, and seismological conditions of the area within a 200-mile radius of New Madrid, site of the largest reported earthquake in the central United States. The study was financed, in part, by the U.S. Nuclear Regulatory Commission.

USGS Professional Paper 954-A, "Geochemical Survey of Missouri—Methods of Sampling Laboratory Analysis and Statistical Reduction of Data," was released in 1976, as was a report entitled "Water Resources of South Central Missouri." The State geological survey also published Report of Investigations (RI) #59, "The Geology of Bates County"; RI #60, "Chemical Analyses of Selected Coals and Some Statistical Implications"; and RI #61, "Studies in Precambrian Geology with a Guide to Selected Parts of the St. Francois Mountains."

Federally funded exploration programs were underway by the State geological survey to evaluate the tar sands in western Missouri and possible coal areas in north-central Missouri. Private industry conducted coal exploration studies. Base metal exploration continued in the Viburnum Trend and the Higdon areas, but delays in issuing prospecting permits on national forest lands have kept exploratory drilling from expanding to other potentially mineralized areas or extensions of existing mining areas. Interest in the zinc potential in the Springfield and Joplin areas was also evidenced by drilling activities and by re-

ferrals to the Federal Bureau of Mines Tri-State Catalog maintained in Joplin. One company was reported to be exploring for tin in Madison County.

A State Highway Department project north of Jefferson City pumped 5 million yards of sand from the Missouri River to

serve as highway fill for U.S. Highway 63 construction.

St. Joe Minerals Corp. presented the title to 8,000 acres of land south of Flat River to the State on September 28. This will be developed into the second largest Missouri State park.

REVIEW BY MINERAL COMMODITIES

In 1976, metals accounted for about 49% of the total value of the State's mineral output compared with 53% in 1975 and 56% in 1974. Nonmetal production was about 43%, and mineral fuels increased to over 7%.

METALS

Aluminum.—Noranda Aluminum, Inc., increased primary aluminum production at its New Madrid plant at midyear by the addition of a second 70,000-ton-per-year potline. The new potline is equipped with air-pollution-control equipment. Alumina feed material is received from outside the State.

Copper.—The output of copper declined 22% during the year. Copper is produced as a byproduct of lead production, but since the lead-to-copper ratio in the ore is extremely variable, the changes in lead production from year to year will not directly affect copper production. Lead-to-copper ratios of production from the various mines in 1976 ranged from less than 20 to 1 to more than 200 to 1, with an average of approximately 50 to 1.

Iron Ore.—Iron ore production was essentially unchanged compared with that of the previous year. Over 40,000 tons of iron

concentrates was sold for heavy media, ceramic magnets, and pigment material.

Meramec Mining Co.'s Pea Ridge property, south of Sullivan, exploded more than 1 million pounds of Tovex water gel in a matter of milliseconds to fragment 2.98 million tons of ore as a part of its pillar recovery program.

Pilot Knob Pellet Co., in an effort to reduce the alkali content of its concentrates, installed a flotation circuit to remove feldspar from its magnetic concentrates.

Table 5.—Missouri: Tenor of lead ore milled and concentrates produced in 1976

Total material	short tons--	8,657,845
Metal content of ore: ¹		
Copper	percent--	0.14
Lead	do.....	6.00
Zinc	do.....	1.15
Concentrates produced and average content:		
Copper	short tons--	22,957
Recovery ratio	percent--	.27
Average copper content	do.....	27.93
Lead	short tons--	705,752
Recovery ratio	percent--	8.15
Average lead content.....	do.....	73.01
Zinc	short tons--	153,611
Recovery ratio	percent--	1.77
Average zinc content.....	do.....	58.57

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

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

	1974	1975	1976
Mines producing: Lode	10	9	9
Material sold or treated: Lead ore	9,110	8,468	8,658
Production (recoverable):			
Quantity:			
Silver	2,387,250	2,525,042	2,277,013
Copper	12,665	14,258	11,050
Lead	562,097	515,958	500,991
Zinc	91,987	74,867	83,530
Value:			
Silver	\$11,244	\$11,161	\$9,905
Copper	19,580	18,308	15,382
Lead	252,944	221,862	231,458
Zinc	66,047	58,396	61,812
Total ¹	349,814	309,726	318,556

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

Table 7.—Total value of mineral production in Missouri and production and value of lead in Missouri and the United States

Year	Total value of Missouri mineral production (thousands)	Lead production					
		Missouri			United States		
		Quantity (short tons)	Value (thousands)	Percent of U.S. production	Percent of world production	Quantity (short tons)	Value (thousands)
1972	\$451,817	489,397	\$147,113	79.1	r 12.9	618,915	\$186,046
1973	512,634	487,143	158,711	80.8	r 12.7	603,024	196,465
1974	691,049	562,097	252,944	84.7	r 14.9	663,370	298,742
1975	722,728	515,958	221,862	83.0	r 13.8	621,464	267,230
1976	785,160	500,991	231,458	82.2	13.5	609,546	281,610

r Revised.

Lead.—Missouri lead output, responding to economic conditions, declined from an alltime high of 562,097 tons in 1974 to 515,958 tons in 1975 and 500,991 tons in 1976. A noticeable gain in monthly production was recorded late in the year. Missouri continued to account for over 82% of the Nation's mined lead production.

A labor strike at the ASARCO, Inc., smelter at Glover, which started September 1, continued throughout the last 4 months of 1976 and into 1977. Ozark Lead Co., which normally supplies more than 80% of the concentrates for the smelter, continued to operate. As its lead-concentrate stockpiles increased, Ozark shipped concentrates to smelters outside the United States.

The Amax Lead Co. of Missouri smelter had several pollution-control projects underway. A new electric matte-smelting furnace was expected to reduce fuming prob-

lems within the plant. Zero water discharge from the smelter plant site is expected to be achieved by a project for the control of air and water pollution, which includes a water-scrubbing system to curtail and contain fumes and dusts, construction of a lake to contain all runoff from the plant, and a recycling system to utilize the recovered process and runoff waters.

No new lead mines were opened or planned, nor were any abandoned during the year.

Silver.—Missouri continued to be the sixth largest silver-producing State and accounted for approximately 7% of the silver produced in the Nation. All production results as a byproduct of lead-zinc smelting.

Zinc.—Missouri regained the top position as the zinc-producing State with a total production of 83,530 tons.

A smelter strike in Oklahoma during the first half of the year caused Ozark Lead Co.

to stockpile concentrates. Zinc-concentrate shipments resumed about the same time that lead-concentrate shipments were curtailed by the smelter strike at ASARCO's Glover smelter.

Ozark's regrind and flotation circuit has been successful in lowering the dolomite content of the zinc concentrate to make it acceptable as feed for the electrolytic smelter. The Magmont mine was preparing to use a somewhat similar system for improving the grade of its zinc concentrates. St. Joe Minerals Corp. developed a leach-flotation circuit whereby zinc concentrates are treated with sulfuric acid to dissolve attached dolomite and the leached residue is refloated to separate any calcium sulfate which might have formed during the leaching as well as other gangue minerals liberated during the leaching process.

NONMETALS

In 1976, nonmetals accounted for 43% of the total value of mineral output, compared with 40% in 1975.

Output of barite and clays were down from the previous year. Stone production was essentially the same, and that of cement, sand and gravel, and lime increased.

Flat River Glass Co. began construction of a 400,000-square-foot plant to manufacture glass artwork bottles. The plant, expected to be operational in mid-1977, will keep the Flat River area active in the mineral industry now that the lead mines in the immediate area have closed.

Barite.—Barite production, which peaked at 337,000 tons in 1966, decreased another 27% this year to 124,300. All of the production was from the Washington County barite district where the barite occurs as shallow, low-grade residual deposits that require large areas for mining. Urbanization, increased population, and generally improved economic conditions limited the availability of minable sites. In addition, with increasing environmental constraints and competition from the high-grade deposits in Nevada, the downward trend in production is likely to continue. Pfizer, Inc., ceased operating barite mines in Missouri. Well-drilling uses accounted for 56% of the barite sold with the remainder going for chemicals, paint, rubber, fillers, and other uses.

Table 8.—Missouri: Portland cement salient statistics
(Short tons)

	1975	1976
Number of active plants -----	7	7
Production -----	3,919,181	4,334,448
Shipments from mills:		
Quantity -----	3,961,695	4,352,669
Value -----	\$116,259,872	\$142,975,522
Stocks at mills, Dec. 31 -----	387,488	376,149

Table 9.—Missouri: Masonry cement salient statistics
(Short tons)

	1975	1976
Number of active plants -----	4	4
Production -----	66,314	69,691
Shipments from mills:		
Quantity -----	64,678	75,773
Value -----	\$2,110,360	\$2,718,087
Stocks at mills, Dec. 31 -----	13,436	7,974

Cement.—Seven cement plants operating along riverways produced over 4.4 million tons of cement, an increase of approximately 10% compared with 1975 production. Six of the plants operated along the Mississippi River between Cape Girardeau and Hannibal and the seventh on the Missouri River at Kansas City. Missouri Portland Cement Co. at St. Louis was installing air-pollution controls to meet emission standards. Marquette Cement Manufacturing Co. announced preliminary planning for a new plant at its Cape Girardeau site.

Clays.—Clay production declined compared with that of 1975. Common clay and shale continued to account for almost 60% of the tonnage but only about 14% of the total value. Major uses, in order of tonnage consumed, were cement manufacturing, refractories, brick and tile, lightweight aggregate, chemicals, and absorbents.

An agreement in principle was reached between the W. S. Dickey Clay Manufacturing Co. and the U.S. subsidiary of Hepworth Ceramic Holdings, Ltd., allowing Hepworth to purchase all outstanding shares of Dickey common stock.

Table 10.—Missouri: Clays sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Other clays		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1972-----	894	5,512	1,677	3,583	W	W	2,571	9,096
1973-----	329	7,563	1,565	2,371	¹ 157	^{1 2} 1,692	2,551	11,626
1974-----	924	10,761	1,542	2,391	² 99	W	2,565	13,151
1975-----	854	11,285	1,209	1,928	² 105	W	2,168	13,214
1976-----	809	11,723	1,256	2,124	² 68	1,068	2,133	14,915

W Withheld to avoid disclosing company proprietary data; excluded from total.

¹ Bentonite.

² Kaolin.

Iodine.—Crude iodine was not produced in Missouri; however, over 1.5 million pounds of crude iodine was used by three companies, located in Springfield, Kansas City, and St. Louis, to produce various inorganic and organic compounds. Resublimed iodine and potassium, sodium, and ammonium iodine were the principal inorganic compounds produced.

Lime.—Lime was produced in Greene, St. Francois, and Ste. Genevieve Counties by Ash Grove Cement Co., Valley Mineral Products Corp., and Mississippi Lime Co., respectively. Ash Grove Cement Co. and Mississippi Lime Co. reported production of both quicklime and hydrated lime. Valley Mineral produced quicklime and dead-burned dolomite.

Perlite.—Approximately 6,000 tons of perlite was expanded by J. J. Brouk & Co.,

St. Louis, into material for construction aggregate, special foundry use, insulation, horticultural and agricultural aggregate fillers, and miscellaneous industrial uses.

Phosphate Rock.—Meramec Mining Co. continued to market byproduct apatite from its Pea Ridge iron mine for fertilizer production.

Sand and Gravel.—Construction sand and gravel production increased substantially over that of 1975 to reach a new record of over 14 million tons. Approximately 45% of the sand and gravel was used as concrete or asphaltic concrete aggregate; 32%, as fill; and 17%, as roadbase and coverings. Industrial sand production increased to slightly over 900,000 tons, but this was 35% below the record production of 1974.

Table 11.—Missouri: Construction aggregate (blended sand and gravel)
and industrial sand and gravel sold or used commercially by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mix concrete):				
Nonresidential and residential construction	3,336	5,160	3,529	5,982
Highway and bridge construction	359	594	345	489
Other construction (dams, waterworks, airports, etc.)	181	245	106	151
Concrete products (cement blocks, bricks, pipe, etc.)	490	844	534	918
Bituminous paving (asphalt and tar paving)	845	1,575	1,438	2,607
Roadbase and subbase	1,352	1,653	1,747	2,840
Fill	554	864	4,068	3,631
Other	161	340	155	367
Unprocessed:				
Roadbase and subbase	306	348	327	376
Fill	133	149	295	378
Other	W	W	W	W
Industrial sand and gravel	824	4,456	901	5,596
Total	8,541	16,228	13,445	¹ 23,334

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

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

Table 12.—Missouri: Construction aggregate (blended sand and gravel) sold or used for publicly funded projects by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mix concrete):				
Nonresidential and residential construction ---	32	87	72	196
Highway and bridge construction -----	646	1,125	540	1,009
Other construction (dams, waterworks, airports, etc.) -----	17	27	131	194
Bituminous paving (asphalt and tar paving) -----	285	495	349	592
Roadbase and subbase -----	96	142	201	343
Fill -----	W	W	443	709
Other -----	W	W	35	39
Unprocessed:				
Roadbase and subbase -----	101	78	134	104
Fill -----	4	2	--	--
Other -----	--	--	24	27
Total ¹ -----	1,211	1,988	1,930	3,215

W Withheld to avoid disclosing company proprietary data; included in "Total."

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

Stone.—Five companies quarried dimension stone for rough monumental stone, house stone veneer, cut stone, and other uses. Output decreased 3% to 4,084 tons valued at \$914,600. Leading producers were Heyward Granite Co. and Carthage Marble Corp. Crushed stone was produced by 173 companies at 287 quarries for roadstone, cement, concrete, and other uses. Output increased 1% to 47,542,000 tons valued at \$97,412,000. Leading producers were Moline Consumers, Mississippi Lime Co., and West Lake Quarry & Material Co.

Among the States, Missouri ranked fourth in total output of crushed stone and fourth in crushed limestone.

Sulfur.—Sulfur was recovered from oil-refining operations at Amoco Oil Co.'s Sugar Creek refinery, and sulfuric acid was produced as a lead-smelting byproduct at the Herculaneum smelter of St. Joe Minerals Corp. and the Amax Lead Co. of Missouri smelter at Boss. A small amount of pyrite concentrate was sold by Meramec Mining Co. for use in lead smelting.

Vermiculite.—Exfoliated vermiculite, produced by J. J. Brouk & Co., St. Louis, and W. R. Grace & Co. in St. Louis and Kansas City, was sold as construction aggregate, loose fill insulation, block insulation, packing insulation, soil conditioning, fertilizer carrier, and fireproofing material.

Table 13.—Missouri: Production of crushed stone, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Roadstone -----	5,490	11,250	8,428	17,820
Cement manufacture -----	5,580	8,142	6,254	10,010
Concrete aggregate -----	7,086	14,463	5,667	11,950
Agricultural limestone -----	4,385	10,029	5,038	11,120
Dense-graded roadbase stone -----	6,483	14,367	4,308	9,333
Lime manufacture ¹ -----	3,067	4,913	3,430	5,511
Surface treatment aggregate -----	2,951	7,140	3,047	7,344
Riprap and jetty stone -----	3,400	5,349	2,675	4,101
Bituminous aggregate -----	3,148	7,159	2,576	6,174
Macadam aggregate -----	2,820	4,775	2,570	4,334
Railroad ballast -----	732	1,563	1,220	2,768
Flux stone -----	W	W	W	675
Mineral food -----	120	433	136	446
Other filler -----	54	268	64	320
Asphalt filler -----	52	120	W	W
Other uses ² -----	1,615	4,557	2,130	5,505
Total³ -----	46,984	94,529	47,542	97,412

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

¹ Includes dead-burned dolomite.

² Includes stone used for sulfur removal from stack gases, roofing granules, glass, mine dusting, whitening, filter stone (1975), terrazzo, chemicals, and uses indicated by symbol W.

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

Table 14.—Missouri: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975		1976	
	Quantity	Value	Quantity	Value
Dimension -----	4	1,006	4	915
Crushed and broken -----	46,984	94,529	47,542	97,412
Total -----	46,988	95,535	47,546	98,327

MINERAL FUELS

Mineral fuels comprised slightly more than 7% of the value of the State's mineral output. Coal was the only mineral fuel produced in significant quantities, although small amounts of oil and gas were produced.

Missouri Energy Agency of DNR published "Missouri Energy Profiles." This publication contains a vast array of data which will serve as the Missouri energy data base.

The potential importance of Missouri's coal resources in meeting the State's energy requirement prompted the Missouri Energy Council to establish a Missouri Coal Research and Development Committee. The committee, consisting of representatives from State and Federal agencies, universities, coal producers, and coal consumers, was charged with recommending the State's direction in coal research and resource de-

velopment. A report of the committee's findings and recommendations was prepared for the Governor and the Missouri Energy Council shortly after yearend.

Higher fuel costs and/or the availability of natural gas had a significant impact on the mineral industry, particularly in lead and aluminum smelting, cement and lime manufacturing, in the firing of iron ore pellets, and in the manufacture of structural and refractory clay products.

Coal.—Thirteen strip mines operated within the State as production increased 8% to 6.1 million tons, exceeding the alltime high of 5.67 million tons set in 1917. Pittsburg & Midway Coal Mining Co., Peabody Coal Co., and Missouri Mining Co. produced over 93% of the total from seven strip mines, accounting for more than 500,000 tons each. Seven operating mines produced less than 7,000 tons each.

Table 15.—Missouri: Bituminous coal production from strip mines, by county, in 1976

(Thousand short tons and thousand dollars)

County	Number of mines	Production	Value
Barton -----	1	558	W
Bates -----	1	1,453	W
Henry -----	2	1,728	W
Howard -----	1	17	W
Macon -----	1	632	W
Putnam -----	1	648	W
Randolph -----	4	747	W
Vernon -----	2	292	W
Total -----	13	6,075	56,934

W Withheld to avoid disclosing company proprietary data.

Coal-leasing activity indicated that Missouri's coal production would continue to expand at a moderate rate. Several of the medium-sized producers were planning to expand their operations.

Kennecott Copper Corp. received numerous bids on its \$1 billion St. Louis Peabody Coal Co. In late August, the Federal Trade Commission asked the U.S. Appeals Court to hold Kennecott and its directors in civil contempt and impose fines because Kennecott was apparently failing to comply with a court order to divest Peabody. Negotiations were still underway at yearend.

Petroleum and Natural Gas.—During 1976, the Missouri Oil and Gas Council permitted 48 wells, 45 of which were completed by yearend. This figure is a 50% decline from the 91 wells reported in 1975. The major cause of this decline was the reduction in the number of shallow stratigraphic tests in the Forest City basin and within the heavy oil area of western Missouri. However, drilling continued into 1977 by the Division of Geology and Land Survey, to evaluate and inventory the tar sands in western Missouri, under an ERDA grant.

The Ke-La-Da Enterprises' No. 1 Fee, located in Cass County, was the only new

gas discovery in 1976. Tests were being conducted to determine the feasibility of commercial development.

All of Missouri's oil wells are classed as stripper wells. According to the national stripper well survey for 1976, Missouri had 173 stripper wells that produced a total of 60,295 barrels of crude oil.

The Missouri Oil and Gas Council was again granted the authority to regulate the injection of fluids or the return of fluids into subsurface formations in connection with oil and gas operations. The Council revised and rewrote existing rules and regulations to conform to the State Code of Regulations.

Senate Bill No. 13, effective August 1976, added tar sands to the commodities included under Missouri reclamation strip mining statutes.

Exploration drilling was underway in a coordinated program by USGS and the Missouri, Kansas, and Oklahoma geological surveys. Preliminary findings indicated that the areal extent of oil-saturated sandstone within the tristate area is somewhat less than had previously been calculated and that the deposits are discontinuous, appearing as relatively small pods in areas where gross sand thickness seems to be greatest.

Table 16.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt, native:			
Bar-Co-Roc Asphalt Co	Box 11 Iantha, Mo. 64753	Mine	Barton.
Barite:			
Dresser Industries, Inc	Box 8 Fotosi, Mo. 63604	Mine and mill	Washington.
General Barite Co	402 South 2d St. Desoto, Mo. 63020	Mine	Do.
Milhem, Inc	Mineral Point, Mo. 63660	Mine and mill	Do.
NL Industries, Inc	Box 2808 St. Louis, Mo. 63111	do	St. Louis and Washington.
Cement:			
Alpha Portland Cement Co.	15 South 3rd St. Easton, Pa. 18043	Plant and quarry	St. Louis.
Dundee Cement Co. ^{1,2}	Box 317 Dundee, Mich. 48131	do	Pike.
Marquette Cement Manufac- turing Co. ^{1,2}	First American Center Nashville, Tenn. 37238	do	Cape Girardeau.
Missouri Portland Cement Co. ^{1,2}	7751 Carondelet Ave. St. Louis, Mo. 63105	do	Jackson and St. Louis.
River Cement Co	Festus, Mo. 63028	do	Jefferson.
United States Steel Corp. ^{1,2}	600 Grant St. Pittsburgh, Pa. 15230	do	Ralls.
Clays:			
Dresser Industries, Inc	2 Gateway Center Pittsburgh, Pa. 15222	Mine and plant	Callaway, Gasconade, Mont- gomery, Warren.
Kaiser Aluminum & Chemical Corp.	Box 499 Mexico, Mo. 65265	do	Audrain, Callaway, Gasconade, Mont- gomery, Warren.
United States Gypsum Co	Mexico, Mo. 65265	do	Franklin and Gasconade.
Coal:			
Peabody Coal Co	301 North Memorial Dr. St. Louis, Mo. 63102	do	Henry, Macon, Randolph.
Pittsburg & Midway Coal Mining Co.	1600 Tenmain Center Kansas City, Mo. 64105	do	Barton and Bates.
Iodine:			
Mallinckrodt Chemical Works.	3600 North 2d St. St. Louis, Mo. 63147	Plant	St. Louis.
Syntex Agribusiness	1919 West Sunshine Springfield, Mo. 65805	do	Greene.
West Agro-Chemical, Inc	501 Santa Fe Kansas City, Mo. 64102	do	Jackson.
Iron Ore:			
Meramec Mining Co	Route 4 Sullivan, Mo. 63080	Underground mine.	Washington.
Pilot Knob Pellet Co	Box 26 Ironton, Mo. 63650	do	Iron.
Lead:			
Amax Lead Co. of Missouri ³	Boss, Mo. 65440	do	Do.
Cominco American, Inc. ³	Bixby, Mo. 65439	do	Do.
Ozark Lead Co. ³	Sweetwater, Mo. 63680	do	Reynolds.
St. Joe Minerals Corp. ³	Viburnum, Mo. 65566	do	Crawford, Iron, Reynolds, Washington.
Lime:			
Ash Grove Cement Co	1000 Tenmain Center Kansas City, Mo. 64105	Plant	Greene.
Mississippi Lime Co. ²	7 Alby St. Alton, Ill. 62002	do	Ste. Genevieve.
Valley Mineral Products Corp.	902 Syndicate Trust Bldg. St. Louis, Mo. 63101	do	St. Francois.
Perlite, expanded:			
J. J. Brouk & Co	1367 South Kingshighway Blvd. St. Louis, Mo. 63110	do	St. Louis.
Roofing granules:			
GAF Corp	Box 278 Annapolis, Mo. 63620	do	Iron.

See footnotes at end of table.

Table 16.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (industrial):			
Green Quarries, Inc -----	Box 257 Carrllton, Mo. 64633	Dredge -----	Carroll, Chariton, Ray.
Holiday Sand & Gravel Co.	6811 West 63rd St. Overland Park, Kans. 66202	----do -----	Various.
List & Clark Construction Co.	-----do -----	----do -----	Platte.
Martin Marietta Co -----	110 East Main St. Rockton, Ill. 61072	Plant and pit ----	Jefferson.
Missouri Gravel Co -----	Box 9 LaGrange, Ill. 60525	Pit and plant ----	Lewis.
Penn Glass Sand Corp ----	Box 187 Berkley Springs, W. Va. 25411	Plant and pit ----	St. Charles and St. Louis.
Riverside Sand & Dredging-	5000 Bussen Rd. St. Louis, Mo. 63129	Dredge -----	St. Louis.
St. Charles Sand Co -----	Route 1, Box 252 Hazelwood, Mo. 63042	Plant -----	Do.
Unisil Corp -----	Greenwich Office Park Four Greenwich, Conn. 06830	Plant and pit ----	Jefferson.
Winter Bros. Material Co.-	13098 Gravois Rd. St. Louis, Mo. 63127	Plant -----	St. Louis.
Stone:			
Ash Grove Cement Co ----	Box 70 Butler, Mo. 64730	Quarries -----	Bates, Greene, Jackson, Vernon.
Gordon Bros. Quarries, Inc-	Box 127 Forest City, Mo. 64451	----do -----	Andrew and Holt.
Midwest Precote Co -----	7600 East 17th St. Kansas City, Mo. 64126	----do -----	Clay and Platte.
Missouri Pacific Railroad Co.	210 North 13th St., Rm. 200 St. Louis, Mo. 63103	----do -----	Wayne.
Moline Consumers -----	313 16th St. Moline, Ill. 61265	----do -----	Jefferson, Knox, Lewis, Monroe, Pike, Ralls, St. Louis, Shelby, Wayne.
Fred Weber, Inc -----	7929 Alabama Ave. St. Louis, Mo. 63111	----do -----	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co.	Route 1, Box 206 Taussig Rd. Bridgeton, Mo. 63042	----do -----	Cape Girardeau, St. Louis, Scott.
Vermiculite, exfoliated:			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, Mass. 01109	Plant -----	St. Louis.

¹ Also clays.² Also silver, copper, zinc.³ Also silver, copper, and zinc.

The Mineral Industry of Montana

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Montana Bureau of Mines and Geology for collecting information on all minerals.

By George T. Krempasky ¹ and Don C. Lawson ²

The value of mineral production in Montana in 1976 was \$636 million, an increase of 11% over that of 1975. The accumulated value of production of the mineral fuels—coal, petroleum, natural gas, natural gasoline, and liquefied petroleum gases—accounted for 67% of the total output value of 1976. The accumulated value of metallics produced—copper, silver, gold, tungsten, lead, zinc, antimony, and iron—accounted for 22.7% of the total output value of 1976. The accumulated production value of non-metallics—barite, clays, cement, fluorspar,

gypsum, lime, phosphate rock, peat, sulfur, stone, sand and gravel, talc, vermiculite, pumice, and gem stones—accounted for 10.3% of the total output value.

Based on value of production, Montana ranked first in talc production, fourth in silver and copper, and seventh in gold production when compared with production from other States.

¹ State Liaison Officer, Bureau of Mines, Helena, Mont.

² Field agent, Montana Bureau of Mines and Geology.

Table 1.—Mineral production in Montana ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony ----- short tons..	273	\$813	150	\$318
Clays ----- thousand short tons..	223	² 1,878	192	W
Coal (bituminous) ----- do.....	22,054	111,579	26,231	128,534
Copper (recoverable content of ores, etc.) ----- short tons..	87,959	112,940	91,111	126,827
Gem stones ----- do.....	NA	400	NA	170
Gold (recoverable content of ores, etc.) ----- troy ounces..	17,259	2,787	24,075	3,017
Iron ore (usable), thousand long tons ----- gross weight..	18	W	18	W
Lead (recoverable content of ores, etc.) ----- short tons..	205	88	92	43
Lime ----- thousand short tons..	221	5,188	224	5,980
Natural gas ----- million cubic feet..	40,734	17,638	42,563	18,941
Peat ----- thousand short tons..	1	51	W	W
Petroleum (crude) ----- thousand 42-gallon barrels..	32,844	257,169	32,814	276,419
Pumice ----- thousand short tons..	--	--	5	8
Sand and gravel ----- do.....	4,127	6,963	4,786	7,336
Silver (recoverable content of ores, etc.) ----- thousand troy ounces..	2,617	11,565	3,279	14,262
Stone ----- thousand short tons..	³ 3,130	³ 6,753	3,468	7,994
Talc ----- do.....	W	W	225	2,960
Zinc (recoverable content of ores, etc.) ----- short tons..	110	86	64	47
Value of items that cannot be disclosed:				
Barite, cement, clays (fire clay, 1975), fluorspar, gypsum, natural gas liquids, phosphate rock, stone (dimension, 1975), tungsten ore, vermiculite, and values indicated by symbol W -----	XX	37,252	XX	43,433
Total -----	XX	573,150	XX	636,289
Total 1967 constant dollars -----	XX	226,795	XX	² 228,746

¹ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

² Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

³ Excludes fire clay; included with "Value of items that cannot be disclosed."

⁴ Excludes dimension stone; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Montana, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Beaverhead	\$354	\$567	Stone, silver, sand and gravel, copper, gold, zinc, lead.
Big Horn	W	W	Coal, sand and gravel, petroleum.
Blaine	W	W	Petroleum.
Broadwater	W	W	Iron ore, gold, silver, lead, zinc, copper.
Carbon	W	7,685	Petroleum, stone, clays, sand and gravel.
Carter	W	W	Clays, petroleum.
Cascade	W	1,030	Sand and gravel, stone.
Chouteau	88	88	Sand and gravel.
Custer	W	W	Sand and gravel, stone.
Daniels	12	5	Sand and gravel.
Dawson	9,739	3,405	Petroleum, sand and gravel, stone.
Deer Lodge	5,697	W	Lime, stone, sand and gravel, clays.
Fallon	W	W	Petroleum, natural gas liquids, stone.
Fergus	W	W	Gypsum, stone, sand and gravel, clays, zinc, silver, lead.
Flathead	1,088	1,333	Sand and gravel, stone.
Gallatin	W	12,532	Cement, stone, sand and gravel, clays, lead, silver, zinc.
Garfield	W	(²)	Stone.
Glacier	14,026	W	Petroleum, natural gas liquids, stone.
Golden Valley	9	13	Sand and gravel.
Granite	1,925	2,289	Silver, gold, stone, copper, tungsten, sand and gravel, lead, zinc.
Hill	105	63	Sand and gravel, stone.
Jefferson	10,634	13,805	Cement, stone, silver, gold, sand and gravel, zinc, lead, clays, copper.
Judith Basin	--	W	Lead, silver.
Lake	W	W	Sand and gravel, peat.
Lewis and Clark	W	W	Sand and gravel, stone, silver, gold, zinc, lead.
Liberty	W	W	Petroleum, sand and gravel.
Lincoln	W	W	Vermiculite, stone, sand and gravel, silver, lead, zinc.
McCone	W	W	Petroleum.
Madison	W	W	Talc, gold, silver, lead, zinc, sand and gravel, copper.
Meagher	W	W	Iron ore, stone, lead, silver, zinc.
Mineral	43	266	Stone, sand and gravel.
Missoula	509	W	Sand and gravel, barite, stone, copper, silver.
Musselshell	12,818	15,040	Petroleum, coal, stone.
Park	W	W	Stone, sand and gravel.
Petroleum	W	9	Sand and gravel.
Phillips	(³)	--	
Pondera	W	W	Petroleum, sand and gravel.
Powder River	W	W	Petroleum, pumice.
Powell	W	W	Phosphate rock, stone, sand and gravel, gold, silver, lead, copper, zinc.
Prairie	W	10	Stone.
Ravalli	601	W	Sand and gravel, fluorspar, stone, peat.
Richland	15,553	23,406	Petroleum, coal, lime, natural gas liquids, sand and gravel, stone.
Roosevelt	W	W	Petroleum, natural gas liquids.
Rosebud	W	W	Coal, petroleum, sand and gravel, stone, silver, lead.
Sanders	903	356	Antimony, stone.
Sheridan	W	W	Petroleum, sand and gravel.
Silver Bow	125,165	141,811	Copper, silver, gold, lead, zinc, sand and gravel.
Stillwater	24	W	Petroleum, stone.
Sweet Grass	4	8	Sand and gravel.
Teton	W	W	Petroleum, sand and gravel, stone.
Toole	16,344	W	Petroleum, stone, sand and gravel.
Treasure	1,499	953	Clays.
Valley	W	W	Sand and gravel.
Wibaux	W	W	Petroleum, sand and gravel.
Yellowstone	W	W	Sand and gravel, petroleum, lime, stone, clays.
Undistributed ³	356,013	411,612	
Total ⁴	573,150	636,289	

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

¹ Wheatland County and Yellowstone National Park are not listed because no production was reported.

² Less than ½ unit.

³ Includes natural gas production that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of Montana business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	322.4	331.0	+2.7
Unemployment ----- do-----	24.7	20.0	-19.0
Employment (nonagricultural):			
Mining ----- do-----	6.4	5.9	-7.8
Manufacturing ----- do-----	22.1	23.6	+6.8
Contract construction ----- do-----	12.1	13.5	+11.6
Transportation and public utilities ----- do-----	19.0	19.2	+1.0
Wholesale and retail trade ----- do-----	59.1	63.0	+6.6
Finance, insurance, real estate ----- do-----	10.2	10.6	+3.9
Services ----- do-----	44.3	47.7	+7.7
Government ----- do-----	64.9	65.7	+1.2
Total nonagricultural employment ----- do-----	238.1	249.2	+4.7
Personal income:			
Total ----- millions--	\$4,017	\$4,283	+6.6
Per capita ----- do-----	\$5,384	\$5,689	+5.7
Construction activity:			
Number of private and public residential units authorized -----	3,066	4,750	+54.9
Value of nonresidential construction ----- millions--	\$57.7	\$75.0	+30.0
Value of State road contract awards ----- do-----	\$95.0	\$85.0	-10.5
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	256	339	+32.4
Mineral production value:			
Total crude mineral value ----- millions--	\$573.2	\$636.3	+11.0
Value per capita, resident population ----- do-----	\$768	\$845	+10.0
Value per square mile ----- do-----	\$3,895	\$4,324	+11.0

^P Preliminary.

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

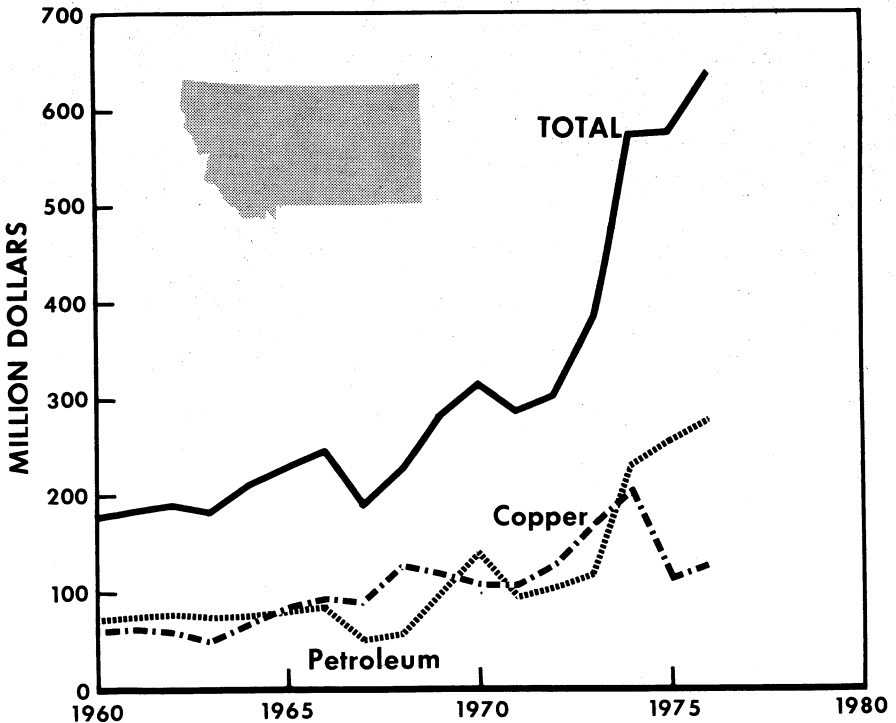


Figure 1.—Value of copper, petroleum, and total value of mineral production in Montana.

Exploration activities for all mineral commodities known to exist in the State continued at a relative high rate during 1976. Major programs were underway seeking gold, silver, lead, zinc, copper, iron, tungsten, molybdenum, platinum-group metals, silver, and uranium. Oil and gas exploration drilling during 1976 exceeded the average footage drilled during the preceding 5 years by 22%. An increased interest has been shown in nonmetallic mineral exploration, especially for talc, vermiculite, and barite. Exploration for coal continued but diverse ownership patterns of potential logical mining units and status of Federal leasing policy has to some extent diminished interest.

It is anticipated that coal production in Montana will increase. However, the growth rate over the next few years will be contingent upon taxation policies, leasing policies, and constraints placed upon construction of coal-fired generating plants or coal gasification plants in Montana.

The Energy Research and Development Administration (ERDA) broke ground for a \$50 million magnetohydrodynamic (MHD) test facility in Butte's industrial park on May 15.

The Anaconda Company placed its modified Arbiter plant back onstream. The plant first operated in the fall of 1974 and was shut down on July 7, 1975. In November 1976, Anaconda removed the billionth ton of material from the Berkeley pit.

ASARCO, Inc., applied for a mining permit from the Department of State Lands in December 1976. The company is planning to mine a stratified deposit containing 0.74% copper and 1.54 ounces of silver per ton. An estimated 48 million tons of minable reserve has been reported.

Montana's mineral processing plants are dependent upon out-of-State raw materials. During 1976, the aluminum plant in Columbia Falls received 100% of its feed from outside the State. The copper refinery of The Anaconda Company at Great Falls received about 50% of its feed from out-of-State sources. The ASARCO smelter at East Helena received close to 95% of its feed from out-of-State sources. The oil refineries throughput was about 84% from outside the State, and the Stauffer Chemical plant in Silver Bow received all of its raw material from outside the State. The value of products from plants processing mineral raw materials was in excess of \$1.3 billion.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels produced in Montana during 1976 were valued at \$427 million compared with \$389 million during 1975, an increase of 10%. The accumulated value of mineral fuels represents 67% of the total value of minerals produced during 1976, a decrease of less than 1% when compared with the total value of 1975 production. Mineral fuels showing production value increases were coal, petroleum, natural gas, and natural gasoline; production value of liquefied petroleum gases declined.

The value of products from plants processing mineral fuels—that is, electrical generating plants and petroleum refining—and imports of natural gas was in excess of \$800 million.

Coal.—Output of coal from eastern Montana mines increased about 19% over 1975 production. The value of coal produced increased 15% compared with the

value of production in 1975. Comparison of the value of production on a calendar year basis is unrealistic as Montana's new tax, reported to be the Nation's highest severance tax, went into effect on July 1, 1975. Thus, one-half year of production was subject to the new tax in 1975. In 1976, the production during the entire year was covered by the new tax. The State collected close to \$23 million in severance tax on coal for fiscal year 1976 (July 1, 1975, to June 30, 1976). The tax collected is reported to be more than four times the amount collected the previous year under a different tax law.

Montana had eight surface mining operations in 1976. Quantity of production per mine ranged from 1,612 tons per year to 10,051,090 tons per year. The largest producer, Decker Coal Co., is reported to be the largest coal mine in the United States, based on annual tonnage.

Montana's coal is primarily used at steam generating electric powerplants. Approximately 95% of the coal produced in Montana in 1976 was exported, about 20,000 tons was used for space heating in Montana, and about 1.2 million tons was used in electrical generating plants in Montana. The distribution of the coal by mining companies was as follows: Knife River Coal Co., Richland County, supplied coal to the Montana-Dakota Utilities plant at Savage; Decker Coal Co., Big Horn County, supplied coal to Commonwealth Edison Co. and Detroit Edison Co.; Peabody Coal Co., Rosebud County, supplied coal to Minnesota Power and Light; Westmoreland Resources supplied coal from its mine in Big Horn County to Northern States Power Co. of Minnesota, Wisconsin Power and Light Co., Dairyland Power Co. of Wisconsin, Interstate Power Co. for its plants in Minnesota and Iowa, and Central Illinois Light Co.; Western Energy Co. produced coal from its mine in Rosebud County for Montana Power Co.'s plants at Colstrip and Billings, and to power producers in Minnesota, Illinois, Wisconsin, Michigan, Iowa, and Indiana.

Decker Coal Co. applied for a permit for the East Decker and North Extension mine areas in Big Horn County. The East Decker is being designed to produce about 6.7 million tons annually. The North Extension will make available about 47 million tons to the present Decker operations. Pacific Power and Light Co. was prospecting an 80-foot seam near Decker. Initial reports indicated that the company is contemplating a surface mine with a capacity of 10 million tons annually, 5 million for its own use and 5 million available for sale. HKH Properties, a Billings firm, obtained lease-options on 6.4 million tons of coal recoverable by surface mining methods and 6.9 million tons of coal recoverable by underground methods. The firm was contemplating a production rate of 500,000 tons annually for industrial uses.

Coal production in Montana is expected to increase in the years to come. Rate of growth the next few years will be somewhat slower than the past 5 years. Under present contracts the coal companies anticipate the delivery of approximately 43 million tons by 1980 and about 49 million tons by 1985.

The status of the construction of Colstrip 3 and 4, two 700-megawatt coal-fired mine-

mouth generating facilities, by a consortium of Northwest utility companies, was uncertain. The utilities first made application for a permit to build the facilities in June 1973 and received conditional approval by the State after 3 years of investigations and hearings. The consortium is in the process of evaluating standards as proposed by the Environmental Protection Agency.

Petroleum and Natural Gas.—Crude petroleum recovery declined less than 1% compared with the 1975 figure of 32.84 million barrels. The value of production in 1976 increased 7% to \$276.42 million. The success of secondary recovery programs in the Bell Creek field helped to maintain relative stable production as compared with 1975 production. Oil was produced from over 150 oilfields as reported by the Oil and Gas Conservation Division of Montana. However, in 1976 about 57% of the oil produced came from six fields: Bell Creek (8.75 million barrels), Pennel (2.77 million barrels), Pine (2.27 million barrels), Cut Bank (2.13 million barrels), Cabin Creek (1.76 million barrels), and Elk Basin (1.07 million barrels).

Gas production was obtained from 45 gasfields and from 16 oilfields with associated gas production. Approximately 7% of the gas produced in Montana was associated with oil production. Gas production increased 4% compared with 1975 production.

The gas was recovered from wells in 23 of Montana's 56 counties. Six gasfields produced in excess of 68% of the total gas recovered in the State: Tiger Ridge (14.782 billion cubic feet), Bowdoin (6.320 billion cubic feet), Cut Bank and Reagan (4.367 billion cubic feet), Cedar Creek (1.753 billion cubic feet), Big Coulee (1.486 billion cubic feet), and Sherard (1.379 billion cubic feet). Montana imported from Canada (34.935 billion cubic feet) and from Wyoming (0.379 billion cubic feet) a total of 35.314 billion cubic feet of gas. The State exported a total of 13.229 billion cubic feet to the Midwest and Canada. Based upon the statistics generated by the State, Montana has relied on imports to meet its gas consumption needs, a deficit of approximately 4.5 billion cubic feet.

A total of 787 holes were drilled during the year, of which 248 were exploratory wells with 17 finds of oil and 8 finds of gas; 539 were development wells with 106

oil finds, 264 gas finds, and 169 dry holes. Wildcats were drilled in 33 counties, and development drilling was accomplished in 25 counties for gas and oil.

Exploration activity continued at a relative high rate during 1976. Although the number of holes drilled in 1976 was 58 less than in 1975, the number of holes drilled exceeded the past 5-year average of 754. In fact, the total footage drilled in 1976 exceeded the total footage average of the past 5 years by about 21%.

Interest continued to be shown in the shallow gas sands. However, exploration drilling to penetrate the deeper oil and gas horizons progressed at a high rate. In addition, interest continued to grow along the Overthrust Belt in western Montana.

Although drilling has penetrated many areas in Montana, most geologists feel that

the State is sparsely drilled and there exist large prospective areas with potential of major reserves.

Montana's refineries were capable of processing over 157,000 barrels per day. During 1976, the average throughput per day was 137,493 barrels with 16.93% of the crude from Montana, 46.69% from Canada, and 36.38% from Wyoming. A total of 50,322,433 barrels of oil was refined in Montana in 1976.

The value of the output of Montana's seven refineries was estimated to exceed \$750 million. It was estimated that more than 4,000 persons were employed in the marketing of petroleum products, an estimated 2,000 were employed in the production of crude oil and natural gas, and about 1,125 were employed in processing and refining of crude.

Table 4.—Montana: Oil and gas well drilling completions in 1976, by county

County	Proved field wells			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Beaverhead	--	--	--	--	--	1	1	15,723
Big Horn	--	--	--	--	1	2	3	10,090
Blaine	--	22	28	--	--	19	69	144,207
Carbon	1	3	1	--	--	3	8	53,048
Carter	--	--	--	--	--	2	2	5,883
Cascade	--	--	--	--	--	4	4	11,310
Chouteau	--	21	6	--	--	16	43	87,976
Custer	--	--	1	--	--	8	9	38,877
Daniels	1	--	--	--	--	1	1	10,455
Dawson	1	--	--	--	--	2	3	30,640
Fallon	12	7	2	--	--	--	21	140,383
Garfield	--	--	2	--	--	4	6	26,159
Glacier	10	37	14	--	1	3	65	182,699
Golden Valley	--	--	--	--	--	2	2	10,805
Granite	--	--	--	--	--	1	1	5,473
Hill	--	20	22	--	1	6	49	95,047
Liberty	9	30	11	--	--	10	60	153,377
McCone	2	--	3	--	--	3	8	59,473
Musselshell	7	--	21	1	--	21	50	212,305
Petroleum	--	--	--	--	--	3	3	8,814
Phillips	--	68	--	--	--	17	80	135,715
Pondera	12	12	1	1	--	10	36	75,109
Powder River	2	3	5	--	--	6	16	71,803
Richland	7	--	5	11	--	8	31	382,305
Roosevelt	5	--	3	2	--	7	17	145,584
Rosebud	17	--	12	1	--	12	42	222,433
Sheridan	4	--	1	1	--	7	13	112,341
Stillwater	--	2	4	--	--	5	11	31,885
Sweet Grass	--	--	--	--	--	3	3	21,034
Teton	3	--	1	--	1	3	8	24,062
Toole	12	42	22	--	3	22	101	216,654
Valley	--	1	--	--	--	7	8	44,575
Wheatland	--	--	2	--	--	3	5	19,765
Yellowstone	2	1	2	--	1	2	8	20,192
Total	106	264	169	17	8	223	787	2,826,801

Source: Annual Review for the Year 1976, Montana Oil and Gas Conservation Division.

METALS

The value of metals produced during 1976 increased 12.8% compared with the value of production in 1975. Metals showing production value increases were copper, silver, gold, tungsten, and iron; decreases in production value were shown for antimony, lead, and zinc. The accumulated value of metals produced during 1976 represented 22.7% of the total value of production, a slight increase above that of 1975.

The value of products from plants processing metallic minerals—that is, copper refining, aluminum refining, lead-silver smelting—was in excess of \$503 million.

Aluminum.—The raw material used in the production of primary aluminum is imported. The effect of the aluminum industry in Montana is considerable. Value of production of primary aluminum increased 56% compared with that of 1975. However, the quantity produced increased by only 13%.

Antimony.—The U.S. Antimony Corp. continued to be one of the largest producers of antimony in the United States. However, economic conditions and a change in ore tenor resulted in a 45% decrease in production and a 61% decrease in value compared with that of 1975.

Copper.—Copper was mined from 23 mines in 8 counties compared with 40 mines in 12 counties during 1975. Copper production increased 4% in 1976 compared with 1975 production; value of production increased 12%. More than 99% of the copper produced came from operations in Silver Bow County. Based on value of production, Montana ranked fourth in copper production when compared with production from other States.

During 1976, all production from Anaconda operations in Butte resulted from open pit mining. As of November 1976, the billionth ton of material had been removed from the Berkeley pit. This included more than 230 million tons of copper ore. Average production at the Berkeley pit was about 50,000 tons of ore per day.

The Anaconda Company placed its modified Arbiter plant, reported to be the first commercial use of hydrometallurgy to recover copper and other metals from ores, back onstream. The plant, east of Anaconda, first operated in the fall of 1974 and was shutdown on July 2, 1975, for modifications. The plant was reopened at about one-fourth of its designed capacity of 6 million pounds of copper monthly and reached one-third of capacity at the end of September.

ASARCO, Inc., has filed a notice of intent to conduct mining operations on U.S. Forest Service land in Lincoln County. The mineral deposit was discovered by Bear Creek Mining Co., and subsequently an agreement was entered into by ASARCO and Bear Creek to explore and possibly develop the stratified copper deposit. The deposit, averaging 0.74% copper and 1.54 ounces of silver per ton, contains 64 million tons of ore reserves with approximately 48 million tons of minable reserves. Estimated life of the Troy project, including development, construction, and production, is 19 years. Annual production is estimated to be 3,000,000 tons per year at a rate of 8,500 tons per day on a 7-day week, 24-hour-per-day schedule. In December 1976, ASARCO applied for a mining permit from the Department of State Lands for the Troy project.

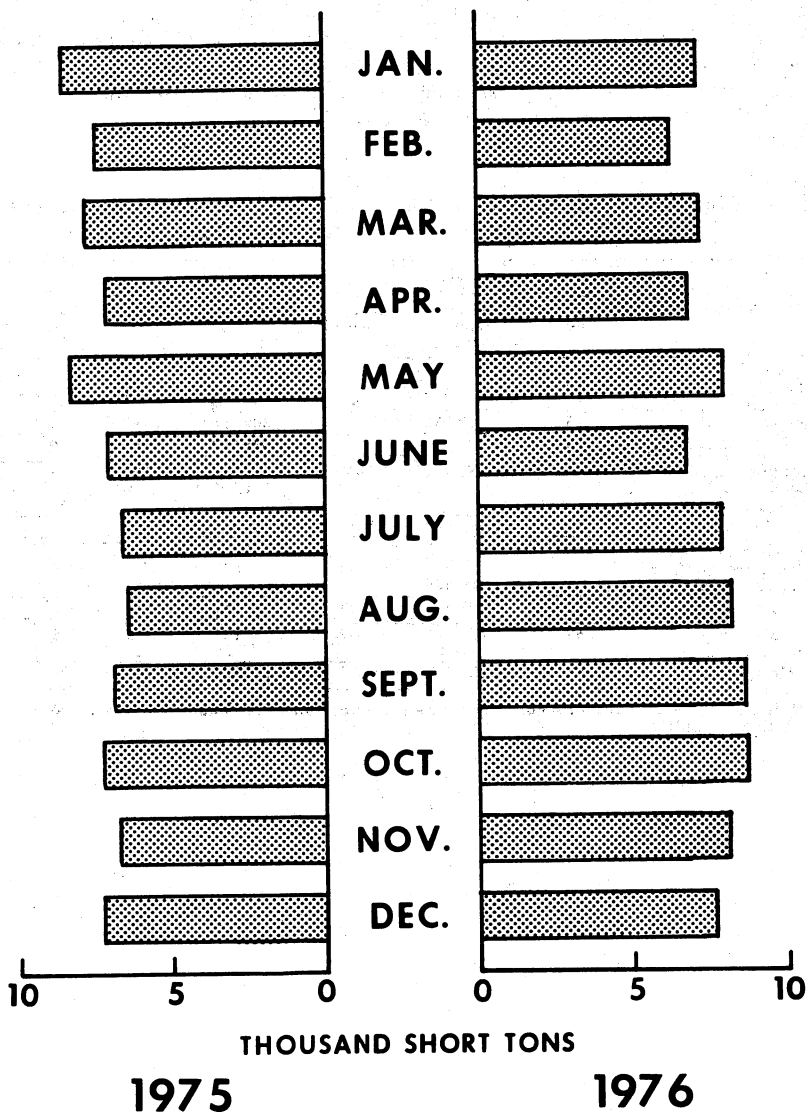


Figure 2.—Mine production of copper in Montana, by month, in terms of recoverable metal.

Gold.—Gold was produced principally as a byproduct of copper refining. During the year, gold output increased to 24,075 ounces, valued at \$3 million, an increase of 8% in value compared with the value of gold produced in 1975. A total of 34 mines in 9 counties produced gold, a decrease from 1975 when 48 mines in 13 counties produced gold. Approximately 82% of the gold produced in Montana

came from the Butte operations. Based on value of production, Montana ranked seventh in gold production when compared with other gold-producing States.

Exploration and evaluation of former gold-producing areas failed to disclose any deposits that can be considered economically feasible. However, efforts by individuals and companies to find ore deposits continue.

Table 5.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ¹	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold	12	6,866	3,106	1,588	1	3	1
Gold-silver	12	5,121	525	27,409	4	47	49
Silver	15	68,122	565	309,226	192	9	6
Total	39	80,109	4,196	338,223	197	59	56
Copper	3	16,780,787	19,843	2,935,682	78,000	3	--
Lead	6	488	7	4,326	2	28	5
Zinc	1	35	--	17	--	(²)	1
Total	10	16,781,310	19,850	2,940,025	78,002	31	6
Other lode material:							
Gold-silver tailings	1	37	13	381	(²)	2	2
Copper precipitates	1	22,785	--	--	12,912	--	--
Total	2	22,822	13	381	12,912	2	2
Total lode	50	16,884,241	24,059	3,278,629	91,111	92	64
Placer	2	--	16	--	--	--	--
Grand total	52	16,884,241	24,075	3,278,629	91,111	92	64

¹ Detail may not add to total because some mines produce more than one class of material.

² Less than ½ unit.

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

County	Mines producing		Material sold or treated ¹ (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1974, total	96	2	23,231,295	28,268	\$4,515,529	3,512,161	\$16,542,278
1975, total	61	2	19,880,426	17,259	2,787,153	2,616,626	11,565,486
1976:							
Beaverhead	4	--	422	12	1,503	5,608	24,395
Broadwater	7	--	242	67	8,395	1,059	4,607
Granite	4	--	70,817	2,729	341,999	297,670	1,294,865
Jefferson	11	1	6,850	648	81,207	24,079	104,744
Lewis and Clark	4	--	92	10	1,253	445	1,936
Madison	6	--	2,071	721	90,356	12,226	53,184
Meagher	1	1	17	31	1,504	153	666
Powell	5	--	137	31	3,885	203	883
Silver Bow	2	--	16,803,487	19,845	2,486,975	2,937,047	12,776,154
Undistributed ²	6	--	106	--	--	139	605
Total ⁴	50	2	16,884,241	24,075	3,017,077	3,278,629	14,262,039
	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1974, total	131,131	\$202,727,887	154	\$69,128	186	\$97,942	\$223,952,764
1975, total	87,959	112,939,745	205	88,328	110	86,190	127,466,902
1976:							
Beaverhead	4	5,786	5	2,328	2	1,828	35,840
Broadwater	(³)	265	6	2,571	2	1,707	17,545
Granite	192	267,027	3	1,352	(³)	144	1,905,387
Jefferson	2	3,310	45	20,562	44	32,553	242,376
Lewis and Clark	--	--	1	396	1	561	4,146
Madison	3	4,450	20	9,181	11	8,174	165,345
Meagher	--	--	5	2,525	1	483	5,178
Powell	(³)	255	(³)	113	(³)	63	5,199
Silver Bow	90,909	126,545,207	3	1,289	1	775	141,810,400
Undistributed ²	(³)	489	4	2,382	1	730	4,206
Total ⁴	91,111	126,826,789	92	42,699	64	47,018	144,195,622

¹ Does not include gravel washed.
² Fergus, Gallatin, Judith Basin, Lincoln, Missoula, and Rosebud Counties combined to avoid disclosing company proprietary data.
³ Less than ½ unit.
⁴ Data may not add to totals shown because of independent rounding.

Table 7.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation	1,634	357	--	--	--
Cyanidation	289	--	--	--	--
Smelting of concentrates from ore	20,930	2,940,859	78,003	22	5
Total	22,853	2,941,216	78,003	22	5
Direct smelting of—					
Ore	1,193	337,032	196	69	57
Precipitates	--	--	12,912	--	--
Tailings	13	381	(¹)	2	3
Total	1,206	337,413	13,108	71	59
Total lode	24,059	3,278,629	91,111	92	64
Placer	16	--	--	--	--
Grand total	24,075	3,278,629	91,111	92	64

¹ Less than ½ unit.
² Data do not add to total shown because of independent rounding.

Table 8.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in Silver Bow County

Year	Mines producing	Material sold or treated (thousand short tons)	Gold (troy ounces)	Silver (thousand troy ounces)
1972	5	17,208	22,535	3,159
1973	12	19,055	24,341	4,070
1974	8	23,188	24,609	3,259
1975	6	19,290	13,528	2,162
1976	2	16,803	19,845	2,937
1882-1976	--	¹ 501,658	2,595,477	670,657
	Copper (short tons)	Lead (short tons)	Zinc (short tons)	Total value (thousands)
1972	123,058	2	--	\$132,656
1973	132,282	--	--	170,208
1974	131,062	--	--	221,902
1975	87,927	12	4	124,647
1976	90,909	3	1	141,810
1882-1976	9,176,994	415,442	2,406,823	5,223,457

¹ Complete data not available: 1882-1904.

Iron Ore.—The R&S Iron Co. produced ore for direct shipping to cement manufacturers. Total output remained the same as that of 1975 with the value of product increasing 13%.

United States Steel Corp. was reportedly moving ahead with plans to develop an iron ore deposit in the Gravelly Range of the Beaverhead Forest in southwestern Montana according to a Bureau of Land Management spokesman. A geologist for U.S. Steel declined to speculate when the deposit might be developed and further stated that if a decision were made immediately to go ahead with the project, no ore would be shipped for at least 10 years.

U.S. Steel has 30 mining claims in the Standard Creek drainage area.

Silver.—The principal source of silver, approximately 89% of the State total, was byproduct output from Anaconda's Berkeley pit in Silver Bow County. Silver production increased about 36% in Silver Bow County and State production increased 25%. Production of silver outside the Butte area was 342,000 ounces, a decrease of 25%. In 1976, the production of silver was from 47 mines in 15 counties compared with production from 53 mines in 15 counties in 1975.

Montana ranked fourth in the production of silver based on the value compared with that of other States.

NONMETALS

The value of nonmetals produced during 1976 increased 17% compared with the value of production during 1975 and represented 10.3% of the total value of mineral production during 1976. Nonmetals showing production value increases were barite, clays, cement, gypsum, lime, stone, sand and gravel, talc, and vermiculite. The production value of fluorspar, phosphate rock, and sulfur decreased during 1976 compared with that of 1975. The value of products from plants processing nonmetallic minerals was in excess of \$39 million.

Cement.—Sales of portland cement increased about 13%, compared with that of 1975, and the value of the commodity rose 28%. Masonry cement sales volume increased 28% with the value of sales increasing 47%. Two plants, one at Trident and the other at Montana City, operated in 1976.

Clays.—Output of clays and shales came from 12 mines in 8 counties. The material produced was used for animal feed, face brick, drilling needs, foundry sand, iron pellets, portland cement, waterproofing and sealing, insulation, concrete blocks, and pottery. There were 10 individuals and/or companies producing clays in Montana. The size of operations ranged from 8 to about 57,000 short tons per year. Output from all mines declined 14% compared with that of 1975, and the value of production increased 25%.

Fluorspar.—One mine in Ravalli County operated by Roberts Mining Co. produced all of the fluorspar in the State. The product was sold mainly to the steel industry as a flux. Mine production decreased by about 75% with the value of production decreasing about 84% when compared with that of 1975.

Gypsum.—United States Gypsum Co. mined gypsum in Fergus County. Crude gypsum production increased 47% and the value of crude production increased 73% compared with 1975 figures. Calcined gypsum production increased 58% over 1975 production. The value of the calcined gypsum produced declined 6% when compared with that of 1975.

Lime.—The Anaconda Company, Holly Sugar Corp., and Great Western Sugar Co. used 224,018 short tons of lime for metallurgical purposes, sewage treatment, and sugar refining. The value of material used

increased 15% while the quantity of product used increased 1% compared with 1975 figures.

Sand and Gravel.—Sand and gravel produced in 1976 was used for construction. Approximately 46% of the material was used for roadbase and coverings, 19% for asphaltic and bituminous mixture, 18% for concrete aggregate, 14% for fill, 2% for concrete products, and 1% for other uses. The value of output increased about 5% and production increased 16% compared with 1975 figures.

Stone.—Stone production increased 11% in quantity and the value of production increased 18% compared with that of 1975. A total of 66 quarries operated in 1976 compared with 77 quarries in 1975. Forty-eight quarries produced less than 25,000 tons and accounted for 10% of the total State production. Ten quarries produced in excess of 100,000 tons on an annual basis and accounted for about 78% of total production. The crushed and broken stone quarried was used as flux, railroad ballast, roadbase, riprap and jetty, and in the manufacture of lime and cement. Three quarries produced dimension stone. The value of dimension stone produced was about \$152,000. Ninety percent of the stone produced was transported by truck; the balance was moved by rail.

Sulfur.—Sulfur was recovered as a by-product from petroleum facilities by two companies operating plants at Billings, Yellowstone County. Value of sulfur produced declined 23% in 1976 compared with that of 1975; output remained the same as the previous year.

Talc.—Three companies operating five mines in Madison County produced more talc in 1976 than in 1975. The value of production was greater than the value received in 1975. Montana ranked second in the Nation in talc production. However, based on value, Montana ranked first. Most of the talc was shipped out of Montana and was used in the manufacture of paper, paint, refractories, toilet preparations, rice polishing, ceramics, roofing materials, and insecticides.

Vermiculite.—W. R. Grace & Co. produced vermiculite from its mine in Lincoln County, primarily for further treatment and sale outside Montana. Production increased about 1% compared with 1975 production, and the value of production increased about 13%.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum: Anaconda Aluminum Company.	Columbia Falls, Mont. 59912.	Plant -----	Flathead.
Antimony: U.S. Antimony Corp -----	Box 643 Thompson Falls, Mont. 59873	Mine and plant ---	Sanders.
Barite: Montana Barite Co -----	Box 3296 Missoula, Mont. 59801	----do -----	Missoula.
Cement: Ideal Cement Co -----	821 17th St. Denver, Colo. 80202	Plant -----	Gallatin.
Kaiser Cement & Gypsum Corp. ¹	300 Lakeside Dr. Oakland, Calif. 94604	----do -----	Jefferson.
Clays: American Colloid Co -----	5100 Suffield Ct. Skokie, Ill. 60076	Pit -----	Carbon.
Hallett Minerals Co -----	Box 491 Forsyth, Mont. 59327	Plant and pit ----	Phillips, Rosebud, Treasure, Valley.
International Minerals and Chemical Corp.	Old Orchard Rd. Skokie, Ill. 60076	Pit -----	Carter.
NL Industries, Inc -----	Box 1675 Houston, Tex. 77001	Pit -----	Do.
Coal: Decker Coal Co -----	Box 12 Decker, Mont. 59025	Strip mine -----	Big Horn.
Knife River Coal Co -----	Box 37 Savage, Mont. 59262	----do -----	Richland.
Peabody Coal Co -----	Big Sky Mine Colstrip, Mont. 59323	----do -----	Rosebud.
Western Energy Co -----	40 East Broadway Butte, Mont. 59701	----do -----	Do.
Westmoreland Resources --	823 West 3d Hardin, Mont. 59084	----do -----	Big Horn.
Copper: The Anaconda Company ² --	Anaconda, Mont. 59711	Smelter, mine, plant.	Silver Bow.
Fluorspar: Roberts Mining Co -----	Box 365 Darby, Mont. 59829	Mine and plant ---	Ravalli.
Gypsum: United States Gypsum Co -	101 South Wacker Dr. Chicago, Ill. 60606	Underground mine and plant.	Fergus.
Iron ore: R&S Iron Co -----	Radersburg, Mont. 59644	Mine -----	Broadwater and Meagher.
Petroleum refining: Big West Oil Co. of Montana.	Kevin, Mont. 59454	Refinery -----	Toole.
Continental Oil Co -----	Billings, Mont. 59101	----do -----	Yellowstone.
Exxon Corp -----	do -----	----do -----	Do.
Farmer's Union Central Exchange, Inc.	Laurel, Mont. 59044	----do -----	Do.
Phillips Petroleum Co ----	Great Falls, Mont. 59401	----do -----	Cascade.
Tesora Petroleum Co -----	8700 Tesora Dr. San Antonio, Tex. 78217	----do -----	Roosevelt.
Westco Refining Co -----	Box 318 Cut Bank, Mont. 59427	----do -----	Glacier.
Phosphate rock: Cominco American, Inc ---	Garrison, Mont. 58731	Mine -----	Powell.
Stauffer Chemical Co. ³ ---	299 Park Ave. New York, N.Y. 10017	Plant -----	Silver Bow.
Sand and gravel: Gallatin Sand & Gravel Co -	Box 248 Bozeman, Mont. 59715	Pit -----	Gallatin.
McElroy & Wilkin Inc ----	Box 35 Kalispell, Mont. 59901	Pit -----	Flathead.
Midland Materials Co ----	Box 2521 Billings, Mont. 59103	Pit -----	Yellowstone.
Barry O'Leary Co -----	Box 1102 Billings, Mont. 59103	Pit -----	Do.
M.S. Ready Mix -----	Box 1501 Missoula, Mont. 59801	Pit -----	Missoula.
Stone: Big Horn Calcium Co ----	Box 118 Frannie, Wyo. 82423	Quarry -----	Carbon and Granite.

See footnotes at end of table.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sulfur: Montana Sulphur Co -----	Billings, Mont. 59101 -----	Plant -----	Yellowstone.
Talc: Cyprus Industrial Minerals Co. -----	555 South Flower St. Los Angeles, Calif. 90017	Open pit and plant.	Madison.
Pfizer Co., Inc -----	Box 1147 Dillon, Mont. 59725	-----do -----	Do.
Vermiculite, crude: W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, Mass. 02140	Plant -----	Lincoln.

¹ Also clays and stone.² Also aluminum, gold, lime, silver, and stone.³ Also stone.

The Mineral Industry of Nebraska

This chapter has been prepared under a cooperative agreement 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 minerals except fuels.

By Robert B. McDougal¹ and Raymond R. Burchett²

In 1976, Nebraska's mineral production was valued at \$123.4 million, an \$11.5 million gain or almost 10.3% above that of 1975. The value of mineral production during 1976 was the highest annual value in Nebraska's history. This increase in values for cement, petroleum, sand and gravel, and stone was mainly the result of inflation and consequent price rises. Petroleum and natural gas accounted for 46% of the State's mineral production value in 1976, compared

with 51% in 1975. Sand and gravel and stone together accounted for 26% of the total value, compared with 24% the previous year. Cement, clays, gem stones, lime, and natural gas liquids comprised the remaining 28% of the mineral production value in 1976.

¹ State Liaison Officer, Bureau of Mines, Topeka, Kans.
² Research geologist, Nebraska Geological Survey, Lincoln, Nebr.

Table 1.—Mineral production in Nebraska¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons--	195	\$416	149	\$345
Gem stones -----	NA	11	NA	11
Natural gas ----- million cubic feet--	2,565	1,388	2,511	1,288
Petroleum (crude) ----- thousand 42-gallon barrels--	6,120	55,133	6,182	55,551
Sand and gravel ----- thousand short tons--	11,759	16,901	² 14,230	² 21,433
Stone ----- do-----	4,242	10,322	4,101	11,054
Value of items that cannot be disclosed:				
Cement, lime, natural gas liquids, and sand and gravel (industrial, 1976) -----	XX	27,734	XX	33,633
Total -----	XX	111,905	XX	123,365
Total 1967 constant dollars -----	XX	44,281	XX	² 44,350

² 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 "Value of items that cannot be disclosed."

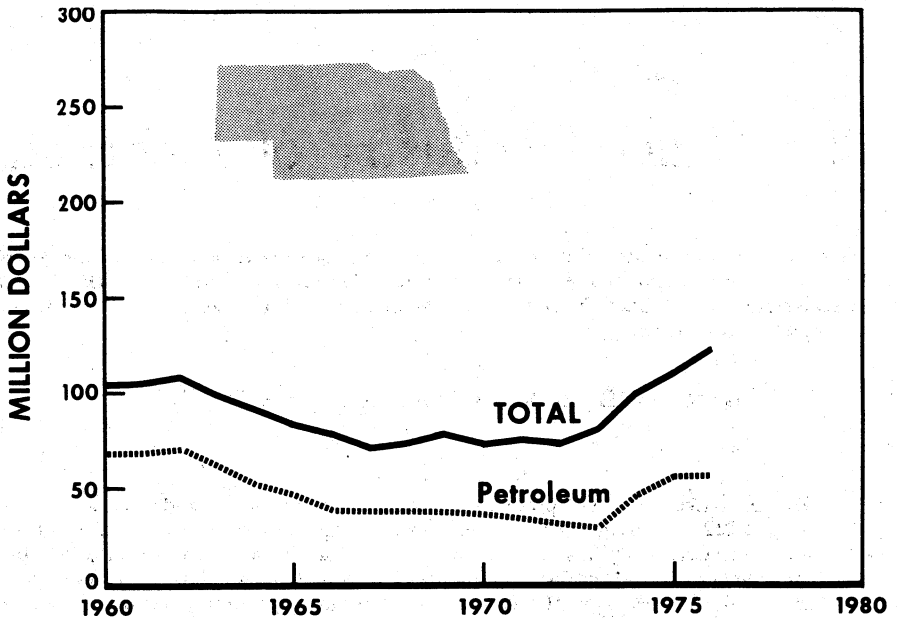


Figure 1.—Value of petroleum and total value of mineral production in Nebraska.

Table 2.—Value of mineral production in Nebraska, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value ²
Adams	W	W	Sand and gravel.
Antelope	\$118	\$118	Do.
Banner	7,246	6,987	Petroleum, natural gas, sand and gravel.
Boone	W	W	Sand and gravel.
Box Butte	--	12	Stone.
Boyd	59	59	Sand and gravel.
Brown	W	W	Do.
Buffalo	451	748	Do.
Burt	2	9	Do.
Butler	253	457	Do.
Case	W	W	Cement, stone, sand and gravel, clays.
Cedar	78	189	Sand and gravel.
Chase	55	48	Do.
Cherry	W	W	Do.
Cheyenne	14,877	14,543	Petroleum, natural gas, natural gas liquids, sand and gravel.
Clay	W	W	Sand and gravel.
Colfax	174	318	Do.
Cuming	692	735	Do.
Custer	194	225	Do.
Dawes	W	W	Do.
Dawson	529	942	Do.
Deuel	W	40	Do.
Dixon	W	W	Stone, sand and gravel.
Dodge	338	553	Sand and gravel.
Douglas	W	W	Sand and gravel, clays.
Dundy	W	W	Petroleum, sand and gravel.
Fillmore	170	W	Sand and gravel.
Franklin	177	197	Do.
Frontier	429	W	Petroleum, sand and gravel, natural gas.
Furnas	W	W	Sand and gravel, petroleum.
Gage	W	791	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Nebraska, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value ²
Garden	W	W	Petroleum, sand and gravel.
Garfield	W	\$24	Sand and gravel.
Grant	\$3	3	Do.
Greeley	W	W	Do.
Hall	488	769	Do.
Hamilton	W	242	Do.
Harlan	W	W	Petroleum.
Hayes	W	W	Sand and gravel.
Hitchcock	W	W	Petroleum, sand and gravel.
Holt	149	522	Sand and gravel.
Hooker	--	W	Do.
Howard	35	W	Do.
Jefferson	W	W	Sand and gravel, clays.
Kearney	24	44	Sand and gravel.
Keith	193	205	Do.
Kimball	11,720	11,421	Petroleum, natural gas liquids, natural gas, sand and gravel.
Knox	171	133	Sand and gravel.
Lancaster	364	483	Stone, clays, sand and gravel.
Lincoln	W	W	Sand and gravel, petroleum.
Loup	--	W	Sand and gravel.
Madison	168	759	Do.
Merrick	253	287	Do.
Morrill	3,080	3,341	Petroleum, sand and gravel, lime, natural gas.
Nance	W	166	Sand and gravel.
Nemaha	W	W	Stone.
Nuckolls	W	W	Cement, sand and gravel, stone.
Otoe	W	--	
Pawnee	W	W	Stone.
Perkins	W	W	Sand and gravel.
Phelps	W	W	Do.
Pierce	103	142	Do.
Platte	908	957	Do.
Polk	167	W	Do.
Red Willow	W	W	Petroleum, sand and gravel.
Richardson	W	W	Petroleum, stone, sand and gravel.
Rock	W	6	Sand and gravel.
Saline	W	W	Do.
Sarpy	W	W	Stone, sand and gravel, clays.
Saunders	W	W	Sand and gravel, stone.
Scottsbluff	3,208	3,124	Petroleum, sand and gravel, lime, natural gas.
Seward	W	56	Stone.
Sheridan	W	W	Sand and gravel.
Stanton	W	W	Do.
Thayer	294	222	Do.
Thomas	136	121	Do.
Valley	10	W	Do.
Washington	W	W	Stone.
Webster	W	148	Sand and gravel.
York	--	101	Do.
Undistributed ³	64,586	73,120	
Total ⁴	111,905	123,865	

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

¹ The following counties are not listed because no production was reported: Arthur, Blaine, Dakota, Gosper, Johnson, Keya Paha, Logan, McPherson, Sherman, Sioux, Thurston, Wayne, and Wheeler.

² Values of petroleum and natural gas are based on the average price per barrel and cubic foot, respectively, for the State.

³ Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Nebraska business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands-----	706.0	719.0	+1.8
Unemployment ----- do-----	42.8	24.0	-48.9
Employment (nonagricultural):			
Mining ----- do-----	1.6	1.7	+6.3
Manufacturing ----- do-----	85.4	87.9	+2.9
Contract construction ----- do-----	28.1	29.1	+3.6
Transportation and public utilities ----- do-----	38.7	41.0	+5.9
Wholesale and retail trade ----- do-----	144.7	152.1	+5.1
Finance, insurance, real estate ----- do-----	34.4	35.7	+3.8
Services ----- do-----	100.2	105.0	+4.8
Government ----- do-----	124.7	121.5	-2.6
Total nonagricultural employment ----- do-----	557.8	573.9	+2.9
Personal income:			
Total ----- millions-----	\$9,061	\$9,450	+4.3
Per capita ----- do-----	\$5,870	\$6,086	+3.7
Construction activity:			
Number of private and public residential units authorized ----- do-----	7,927	10,528	+32.8
Value of nonresidential construction ----- millions-----	\$85.8	\$108.1	+26.0
Value of State road contract awards ----- do-----	\$69.0	\$70.0	+1.4
Shipments of portland and masonry cement to and within the State ----- thousand short tons-----	913	1,047	+14.7
Mineral production value:			
Total crude mineral value ----- millions-----	\$111.9	\$123.4	+10.3
Value per capita, resident population ----- do-----	\$72	\$79	+9.7
Value per square mile ----- do-----	\$1,449	\$1,597	+10.2

^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.

Trends and Developments.—The Federal Power Commission (FPC) approved, with conditions, construction of two powerplants by the Nebraska Public Power District (NPPD) near Sutherland. The first 650,000-kilowatt plant is scheduled for operation in 1978; another 650,000-kilowatt plant is to be in operation in 1980 or 1981 at the same location. FPC, although approving construction, required NPPD to submit a plan to monitor and report the aquatic environment of the affected bodies of water. The approval is for construction only, and NPPD still must obtain an operating permit.

Legislation and Government Programs.—The Nebraska Geological Survey received a \$45,000 grant from the Nuclear Regulatory Commission for an expanded study of the sources of earthquakes in Nebraska. The grant provides funds for the first year of a \$350,000, 5-year research project. Primary attention will be focused on the Nemaha Uplift, a deeply-buried ridge of Precambrian granite extending from eastern Nebraska through Kansas into Oklahoma. Similar research on the ridge

will be conducted by the geological surveys of Kansas and Oklahoma. Purpose of the study was to relate past earthquakes to specific fault zones and to estimate earthquake risk for various parts of the region. The study will aid the Commission in developing siting and design standards for nuclear powerplants in the area.

In 1976, some 669 mining operations were reported to have disturbed 663 acres and restored another 161 acres.³ These operations comprised limestone and sandstone quarries and sand and gravel, silt or siltstone, clay or shale, and peat pits.

Over the last 50 years, a total of 2,966 mines, quarries, and pits have been active at various times in Nebraska. Of this number, 361 were limestone quarries; 83 sandstone quarries; 11 quartzite pits; 2,435 sand, gravel, and silt pits; 24 clay or shale pits; 29 volcanic ash pits; 14 coal mines; 1 chalk mine; 3 flint quarries; and 5 peat pits. These operations have disturbed 33,000 acres, of which nearly one-third have been reclaimed.

³ Burchett, R. R., and G. R. Svoboda. Nebraska Mineral Operations Review, 1976. Nebr. Geol. Survey, 1977.

Various activities of the Nebraska Geological Survey during the year included geologic mapping in western and southwestern Nebraska, drilling in western Nebraska that created some interest in uranium prospecting, and a continuation of

coal mapping in southeastern Nebraska.

Interest and evaluation continued by private industry on the uses of expanded volcanic ash and on the rare-earth elements associated with the Elk Creek anomaly near the Johnson-Pawnee County line.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement manufacturing contributed significantly to Nebraska's mineral production in 1976. Output in 1976 was about 12.5% greater than that of 1975. The production value rose 23.5% owing in part to a modest price increase. Cement was produced by Ash Grove Cement Co. in Cass County and by Ideal Basic Industries, Inc., in Nuckolls County. The chief raw materials used were limestone, common clay and shale, and gypsum. Disposition of output was 59.8% to ready-mix companies, 24% to highway contractors, 9.2% to concrete product manufacturers, 6.3% to building material dealers, and the remainder to other contractors. Distribution of shipments was 59.8% by truck and 40.2% by railroad.

Clays.—Common clay and shale was produced at five operations: Ash Grove Cement Co. in Cass County, Endicott Clay Products Co. in Jefferson County, Omaha Brick Works in Douglas and Sarpy Counties, and Yankee Hill Brick Manufacturing Co. in Lancaster County. Output declined 24% in quantity and 17% in value from that of 1975.

Fertilizer Materials.—Producers of ammonia, urea, and ammonium nitrate included Allied Chemical Co. at La Platte in Sarpy County; C. F. Industries, Inc., at Fremont in Dodge County; and Phillip Chemical Co. at Beatrice in Gage County. Farmland Industries, Inc., produced ammonia in Adams County. Ammonium nitrate was produced at Beatrice in Gage County by Cominco-American, Inc.

Lime.—Great Western Sugar Co. produced lime from limestone shipped from

its quarry in Wyoming. Lime kilns were located at Scottsbluff, Gering, and Mitchell in Scottsbluff County, and at Bayard in Morrill County. Quantity and value of production declined from that of 1975. The lime was used mainly for sugar refining.

Perlite.—The Zonolite Division of W. R. Grace & Co. perlite plant near Omaha, Douglas County, did not operate in 1976.

Pumice.—The La Rue Axtell Pumice Co.'s Le Master mine near Callaway in Lincoln County, inoperative the last 4 years, was abandoned.

Sand and Gravel.—Production of sand and gravel in Nebraska increased 21%; value of production increased 27%. The average value of sand and gravel in 1976 was \$1.51 per ton, compared with \$1.44 in 1975.

Among the largest producers were Central Sand & Gravel Co. in Butler, Hall, Madison, and Platte Counties; Hartford Sand & Gravel Co. in Dodge and Douglas Counties; Lyman-Richey Sand & Gravel Corp. in Cass, Dodge, Douglas, Morrill, Platte, and Saunders Counties; and Western Sand & Gravel Co. in Cass, Dodge, and Saunders Counties. Together, their 23 operations accounted for 30% of Nebraska's output by quantity and 37% by value.

Commercial uses of sand and gravel accounted for 46% of the output, both by quantity and value. The remainder of the production was used in publicly funded projects. The shipments by major use category were concrete aggregate, 36%; road and roadbase, 27%; fill, 13%; asphalt and bituminous, 12%; concrete products, 10%; and other, 2%.

Table 4.—Nebraska: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	1	W	W	1	W	W
Antelope	3	80	118	3	75	118
Banner	2	W	W	2	W	W
Boone	1	W	W	1	W	W
Boyd	1	37	59	1	37	59
Brown	3	W	W	3	W	W
Buffalo	8	518	451	8	720	748
Burt	1	7	2	1	37	9
Butler	4	167	253	4	247	457
Cass	4	756	1,233	4	863	1,421
Cedar	3	68	78	3	109	189
Chase	4	77	55	4	81	48
Cherry	1	W	W	1	W	W
Cheyenne	4	110	160	5	W	W
Clay	3	W	W	3	W	W
Colfax	4	93	174	3	161	318
Cuming	4	446	692	4	465	785
Custer	4	119	194	4	138	225
Dawes	1	W	W	1	W	W
Dawson	7	442	529	5	710	942
Deuel	2	W	31	2	W	40
Dixon	1	W	W	1	W	W
Dodge	4	471	838	5	297	553
Douglas	6	1,524	2,696	8	1,729	3,085
Dundy	--	--	--	1	W	W
Fillmore	1	W	170	1	W	W
Franklin	3	120	177	4	114	197
Frontier	1	19	14	2	W	W
Furnas	2	W	W	3	91	141
Gage	7	129	322	7	211	580
Garden	2	W	W	3	46	17
Garfield	2	W	W	1	16	24
Grant	1	12	3	1	12	3
Greeley	1	W	W	2	W	W
Hall	6	448	488	12	676	769
Hamilton	3	W	W	4	192	242
Hayes	2	W	W	1	W	W
Hitchcock	2	15	27	2	15	24
Holt	9	153	149	13	408	522
Hooker	--	--	--	1	W	W
Howard	1	W	35	3	W	W
Jefferson	3	120	234	4	W	W
Kearney	1	46	24	1	47	44
Keith	5	233	193	4	231	205
Kimball	2	4	1	4	4	1
Knox	6	120	171	6	93	133
Lancaster	1	W	W	1	W	W
Lincoln	11	546	469	10	803	736
Loup	--	--	--	2	W	W
Madison	1	108	168	7	526	759
Merrick	6	218	253	7	232	287
Morrill	5	83	94	6	137	235
Nance	2	W	W	4	114	166
Nuckolls	2	W	W	3	92	217
Perkins	2	W	W	2	W	W
Phelps	2	W	W	2	W	W
Pierce	3	54	103	3	77	142
Platte	7	471	908	6	492	957
Polk	4	117	167	3	W	W
Red Willow	7	181	288	7	112	224
Richardson	3	4	4	2	W	W
Rock	1	W	W	1	4	6
Rock	3	W	W	3	W	W
Saline	3	105	131	2	W	W
Sarpy	4	1,134	1,818	5	1,141	2,164
Saunders	9	561	575	7	551	735
Scottsbluff	2	W	W	3	53	102
Sheridan	1	W	W	2	W	W
Stanton	5	163	294	5	130	222
Thayer	1	W	136	1	82	121
Thomas	1	8	10	2	W	W
Valley	3	W	W	5	91	148
Webster	--	--	--	1	W	101
York	--	--	--	--	--	--
Undistributed	--	1,672	1,910	--	1,764	2,317
Total ¹	225	11,759	16,901	259	14,230	21,483

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
¹ Data may not add to totals shown because of independent rounding.

Table 5.—Nebraska: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value
Construction:				
Processed:				
Sand -----	3,761	4,554	5,093	6,445
Gravel -----	7,105	10,341	9,136	15,038
Unprocessed: Sand and gravel -----	846	860	(²)	(²)
Total ³ -----	11,712	15,555	14,230	21,483
Industrial: Sand and gravel -----	47	270	W	W
Grand total ³ -----	11,759	15,826	W	W

W Withheld to avoid disclosing company proprietary data.

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant for blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

² "Unprocessed sand and gravel" included with "Processed sand and gravel."

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

Table 6.—Nebraska: Sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	5,005	7,363	5,131	8,420
Concrete products (cement blocks, bricks, pipe, etc.) -	1,306	1,810	1,414	2,321
Asphaltic concrete aggregates and other bituminous mixtures -----	1,661	2,432	1,779	2,935
Roadbase and coverings -----	3,016	4,250	3,793	5,523
Fill -----	593	616	1,886	2,076
Other uses -----	142	159	225	208
Total ¹ -----	11,712	16,631	14,230	21,483
Industrial sand and gravel -----	47	270	W	W
Grand total -----	11,759	16,901	W	W

W Withheld to avoid disclosing company proprietary data.

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

Stone.—Seventeen companies produced crushed limestone at 25 quarries in 13 counties for cement, concrete, surface treatment aggregate, and other uses. Output, which decreased 3% to 4,101,000 tons valued at \$11,054,000, accounted for 9% of the State's mineral production value. Unit values increased from \$2.43 per ton in 1975 to \$2.70 per ton in 1976. Four companies with individual output greater than 400,000 tons accounted for 45% of the State's total stone production by quantity. In Cass County, six companies with seven quarries

produced 69% of the stone by quantity and 66% by value. The leading producers were Hopper Bros. Quarries, Ash Grove Cement Co., and Kerford Limestone Co. Together, their 11 operations accounted for 85% of the stone produced and 77% of the value.

Crushed and broken stone was used for cement manufacture, concrete aggregate, bituminous aggregate, surface treatment aggregate, roadbase, riprap, and agricultural purposes. Transportation was 84% by truck, 12% by railroad, 3% by water, and 1% by other modes.

Table 7.—Nebraska: Crushed limestone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate	1,394	3,177	1,244	3,548
Cement manufacture	W	W	1,067	W
Surface treatment aggregate	669	1,686	480	1,340
Roadstone	92	339	323	1,069
Dense-graded roadbase stone	286	594	174	401
Agricultural limestone	169	361	259	636
Bituminous aggregate	410	896	W	W
Riprap and jetty stone	104	350	214	803
Other uses ¹	1,119	2,918	340	3,258
Total ²	4,242	10,322	4,101	11,054

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

¹ Includes stone used in asphalt filler, filter stone, mineral food, railroad ballast, soil conditioning (1975), waste material, and uses indicated by symbol W.

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

Vermiculite.—W. R. Grace & Co., Construction Products Div., was the only producer of exfoliated vermiculite. Crude vermiculite mined in Montana was processed at the company's plant near Omaha in Douglas County. The expanded product was used principally for insulation, concrete, and fireproofing.

MINERAL FUELS

In 1976, the Nebraska Oil and Gas Conservation Commission issued 369 permits to drill for oil and gas, 2% less than in 1975. Of these, 202 were exploration wells, 144 were development wells, and 23 were water disposal wells. Drilling permits for exploratory and development wells were issued largely for Kimball (76), Hitchcock (64), Cheyenne (57), Banner (39), and Morrill (34) Counties.

Nebraska had 322 oil and gas wells completed in 1976 with a total footage drilled of 1,585,079 feet, compared with 338 wells completed with a footage drilled of 1,707,170 feet in 1975. Of the total wells completed in 1976, 89 were productive and 233 were dry. Kimball, Hitchcock, and Cheyenne Counties accounted for 184 of the total wells completed. At yearend 1976, there were 1,308 active oil and gas wells in Nebraska and 394 capped wells. Of the total active oil wells, 1,047 were in Banner, Cheyenne, Kimball, and Red Willow Counties.

Natural Gas.—Reported gross withdrawals of natural gas were 3,308 million

cubic feet, a 16.5% drop from that of 1975. Of this production, nearly 73% was extracted from oil wells and the remaining 27% came from nonassociated gas wells. Marketed natural gas totaled 2,511 million cubic feet in 1976, compared with 2,565 million cubic feet in 1975. Natural gas value in 1976 was \$1,288,000, a decline from the value in 1975 of \$1,388,000. Average wellhead value declined from 54.1 cents per thousand cubic feet to 51.3 cents per thousand cubic feet.

The quantity of natural gas in millions of cubic feet delivered to consumers was as follows:

Consumer	1975	1976
Residential	53,808	54,965
Commercial	40,999	39,683
Industrial, including refinery fuel and carbon black production	72,792	64,267
Electric utilities	37,659	19,575
Others	2,118	9,080

Petroleum.—A total of 6.2 million barrels of petroleum was produced in 1976, compared with 6.1 million barrels in 1975, a 1% gain. The number of active wells increased from 1,190 to 1,291 and the number of capped wells decreased from 437 to 390. The reported unit value of crude petroleum decreased slightly from \$9.01 per barrel in 1975 to \$8.99 per barrel in 1976.

Output was reported in 14 counties; Red Willow, Cheyenne, Kimball, and Banner Counties accounted for 81.4% of the State's production. Sleepy Hollow field in Red Willow County, Nebraska's largest producing field, produced 16.5% of the total.

Table 8.—Nebraska: Number of active and capped oil and dry gas wells at yearend 1976, by county

County	Oil wells		Dry gas wells	
	Active	Capped	Active	Capped
Banner	180	57	--	--
Cheyenne	250	34	16	3
Deuel	--	--	1	--
Dundy	14	--	--	--
Frontier	10	--	--	--
Furnas	3	1	--	--
Garden	2	--	--	--
Harlan	9	--	--	--
Hitchcock	92	16	--	--
Kimball	299	127	--	1
Lincoln	--	1	--	--
Morrill	62	17	--	--
Red Willow	318	103	--	--
Richardson	19	30	--	--
Scottsbluff	33	4	--	--
Total	1,291	390	17	4

Source: Nebraska Oil and Gas Conservation Commission.

Table 9.—Nebraska: Crude petroleum production, by county (Thousand 42-gallon barrels)

County	1975	1976	Principal fields
Banner	791	767	Singleton, Stage Hill, ¹ Johnson.
Cheyenne	1,352	1,391	Jormar, Margate, Southwest Sidney, West Engelland, Filon.
Dundy	47	48	East Indian Creek, Rock Canyon.
Frontier	46	52	Bed Canyon. ²
Furnas	2	4	Southwest Wilsonville.
Garden	6	7	Richard and McCord.
Harlan	20	21	South Alma.
Hitchcock	279	452	Reiher.
Kimball	1,247	1,220	Sloss, Enders, Axial, Bertramson.
Lincoln	1	1	Red Willow Creek.
Morrill	314	330	Bridgeport.
Red Willow	1,775	1,657	Sleppy Hollow, Ackman, Danbury, Bed Canyon. ³
Richardson	36	47	Dawson, Fall City, Barada.
Scottsbluff	204	190	Cedar Valley, Stage Hill, ¹ Minatare.
Total	6,120	6,182	

¹ Partly in Banner and Scottsbluff Counties.

² Partly in Frontier and Red Willow Counties.

Source: Nebraska Oil and Gas Conservation Commission.

Table 10.—Nebraska: Crude oil production in the 25 largest fields in 1976
(42-gallon barrels)

Field	County	Annual output	Average daily output
Sleepy Hollow	Red Willow	1,019,657	2,786
Ackman	do	183,121	500
Silver Creek	do	182,729	499
Jormar	Cheyenne	146,261	400
Dry Creek	Hitchcock	125,272	342
Midway	Red Willow	115,838	317
Bush Creek	Hitchcock	97,972	268
Warden	Cheyenne	95,224	260
Joyce	Banner	91,181	249
Southwest Sidney	Cheyenne	87,478	239
North Dry Creek	Hitchcock	85,898	235
Singleton	Banner	85,818	234
Houthy	Kimball	84,809	232
Bridgeport	Morrill	84,411	231
Middle Creek	Cheyenne and Morrill	76,755	210
Cedar Valley	Scottsbluff	73,835	202
Owasco	Kimball	69,838	191
Danbury	Red Willow	68,781	188
Shelda	Cheyenne	66,477	182
Margate	do	64,254	176
West Engelland	do	63,864	174
Reiher	Hitchcock	63,256	173
Bed Canyon	Frontier and Red Willow	58,053	159
Stage Hill	Banner and Scottsbluff	56,705	155
Schrack	Kimball	54,257	148

Source: Nebraska Oil and Gas Conservation Commission.

Table 11.—Nebraska: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Banner	2	--	7	4	--	16	29	173,187
Buffalo	--	--	--	--	--	1	1	3,350
Cherry	--	--	--	--	--	1	1	4,456
Cheyenne	7	--	17	5	2	22	53	272,335
Dawes	--	--	--	--	--	2	2	3,934
Dundy	4	--	3	3	--	3	13	58,641
Franklin	--	--	--	--	--	1	1	3,445
Frontier	1	--	--	--	--	2	3	10,991
Furnas	--	--	1	1	--	6	8	23,348
Garden	--	--	--	--	--	2	2	7,455
Harlan	--	--	--	1	--	--	1	3,324
Hayes	--	--	--	--	--	2	2	9,319
Hitchcock	26	--	12	8	--	19	65	274,966
Keith	--	--	--	--	--	1	1	4,501
Kimball	4	--	21	3	--	38	66	434,539
Lincoln	--	--	--	--	--	3	3	13,687
Morrill	4	--	6	2	--	17	29	126,453
Nemaha	--	--	--	--	--	1	1	2,247
Nuckolls	--	--	--	--	--	1	1	4,072
Red Willow	3	--	4	--	--	5	12	42,759
Richardson	8	--	--	--	--	5	13	34,660
Scottsbluff	1	--	3	--	--	8	12	62,825
Sheridan	--	--	--	--	--	3	3	5,585
Total	60	--	74	27	2	159	322	1,585,079

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

METALS

The Omaha refinery of ASARCO, Inc., recovered antimony, bismuth, gold, lead,

and silver from lead bullion and other smelter products shipped from ASARCO plants outside Nebraska.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co. ¹ ----	1000 Tenmain Center Kansas City, Mo. 64105	Plant -----	Cass.
Ideal Basic Industries, Inc. ²	420 Ideal Cement Bldg. Denver, Colo. 80202	----do -----	Nuckolls.
Clays:			
Endicott Clay Products Co -	Box 17 Fairbury, Nebr. 68352	Open pit mine and plant.	Jefferson.
Yankee Hill Brick Manufacturing Co.	Route 1 Lincoln, Nebr. 68502	----do -----	Lancaster.
Lime: Great Western Sugar Co.	Box 5038 Denver, Colo. 80217	Plant -----	Morrill and Scottsbluff.
Natural gas³			
Petroleum: ³ CRA, Inc -----	3315 North Oak Trafficway Kansas City, Mo. 64116	Refinery -----	Scottsbluff.
Sand and gravel:			
Behrens Construction Co --	Box 188 Beatrice, Nebr. 68310	Pits and plants --	Gage and Saline.
Central Sand & Gravel Corp.	Box 626 Columbus, Nebr. 68601	Dredging -----	Butler, Hall, Madison, Platte.
Hartford Sand & Gravel Co.	Box Z Valley, Nebr. 68064	Pits -----	Dodge and Douglas.
Lyman-Richey Sand & Gravel Corp.	4815 Cuming St. Omaha, Nebr. 68131	Pits, dredging, and plants.	Cass, Dodge, Douglas, Morrill, Platte, Saunders.
Western Sand & Gravel Co.	Box 80268 Lincoln, Nebr. 68501	----do -----	Cass, Dodge, Saunders.
Stone:			
City Wide Rock & Excavation Co.	38th and Mason Sts. Omaha, Nebr. 68105	Quarries and plants	Sarpy.
Fort Calhoun Stone Co ----	1255 South St. Blair, Nebr. 68008	----do -----	Washington.
Hopper Bros. Quarries ----	Box 383 Weeping Water, Nebr. 68463	----do -----	Cass, Gage, Nemaha, Nuckolls, Pawnee, Saunders.
Kerford Limestone Co ----	Box 434 Weeping Water, Nebr. 68463	Quarry and plant -	Cass.
Nemaha Valley Construction Co.	Box 126 Auburn, Nebr. 68305	----do -----	Richardson.
Vermiculite (exfoliated): W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Plant -----	Douglas.

¹ Also clays and stone.

² Also stone.

³ Most of the major oil and gas companies and many smaller companies operate in Nebraska, and are listed in several commercial directories.

The Mineral Industry of Nevada

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Nevada Bureau of Mines and Geology for collecting information on all minerals.

By Paul V. Fillo¹

The value of Nevada's mineral output reached \$233.7 million in 1976, compared with \$258.9 million in 1975. Production value of metals as a group decreased 27%, nonmetals increased 24%, and mineral fuels (petroleum) increased 114%.

Lower production of the metal commodities, especially copper, gold, lead, silver, and zinc, served to decrease the total value of Nevada's mineral output by 10%. Copper production, which accounted for 35% of the total value of the State's mineral production, was down 22% from that of 1975. Gold and silver values registered significant declines of 33% and 52%, respectively.

Of the 16 nonmetallic materials, 10 showed increases in production, 5 showed decreases, and 1 was unchanged. Substantial percentage gains in value were made by barite, lime, gypsum, and diatomite.

Nevada relied on out-of-State sources to meet its requirements for mineral fuels and metals, and for most of its nonmetal needs other than for construction materials.

Metal ores, concentrates, precipitates, and residues were processed at mills and smelters outside the State. Kennecott Cop-

per Corp. in White Pine County and Kennametal, Inc., in Churchill County were the only smelter operators in the State. Kennecott's smelter at McGill relied totally on Nevada ores.

Most of the State's output of tungsten was shipped to Union Carbide Corp.'s ammonium paratungstate plant at Pine Creek, near Bishop, Calif. Tungsten carbide was produced in substantial quantities in Nevada by Kennametal, Inc., near Fallon, by the unique therman process which produces macrocrystalline tungsten carbide directly from tungsten ore. Concentrates used at this plant were purchased from various domestic and foreign producers.

Iron ore mined in the State was exported or shipped to steel plants in other States; barite was shipped to California, Texas, and Utah for further processing; gypsum was shipped to plants in California; fluor-spar went out-of-State to steel and cement industries; talc shipments went to out-of-State grinding mills; and petroleum production was consigned to refineries in Utah.

¹ State Liaison Officer, Bureau of Mines, Carson City, Nev.

Table 1.—Mineral production in Nevada ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite ----- thousand short tons..	r 947	r \$11,533	900	\$18,379
Clays ² ----- do.....	5	136	7	174
Copper (recoverable content of ores, etc.) ----- short tons..	81,210	104,274	58,160	80,958
Gem stones ----- NA	NA	2,814	NA	1,300
Gold (recoverable content of ores, etc.) ----- troy ounces..	332,814	53,746	287,962	36,087
Gypsum ----- thousand short tons..	558	2,375	792	3,884
Iron ore (usable), thousand long tons ----- gross weight..	109	1,017	W	W
Lead (recoverable content of ores, etc.) ----- short tons..	2,976	1,230	582	269
Mercury ----- 76-pound flasks..	W	W	22,837	2,770
Petroleum (crude) ----- thousand 42-gallon barrels..	115	W	143	W
Pumice ----- thousand short tons..	W	W	388	763
Sand and gravel ----- do.....	8,056	16,848	9,671	20,106
Silver (recoverable content of ores, etc.) ----- thousand troy ounces..	1,609	7,111	784	3,410
Stone ³ ----- thousand short tons..	1,829	4,524	1,904	5,975
Tungsten (W content) ----- thousand pounds..	33	152	99	561
Zinc (recoverable content of ores, etc.) ----- short tons..	5,496	4,237	1,438	1,064
Value of items that cannot be disclosed:				
Cement (portland), clays (common clay, fuller's earth, kaolin), diatomite, fluorspar, lime, lithium compounds, magnesite, molybdenum, perlite, salt, stone (dimension), talc, and values indicated by symbol W -----	XX	48,820	XX	57,983
Total -----	XX	r 258,917	XX	233,683
Total 1967 constant dollars -----	XX	102,453	XX	p 84,009

^p Preliminary. ^r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes common clay, fuller's earth (1976) and kaolin (1976); value included with "Value of items that cannot be disclosed."

³ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Nevada, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Carson City -----	\$284	\$393	Pumice, sand and gravel, stone.
Churchill -----	876	1,091	Diatomite, tungsten, sand and gravel, silver, salt, gold, pumice, stone, zinc, lead, copper.
Clark -----	21,070	25,527	Sand and gravel, lime, stone, gypsum, clays, gold, silver, lead.
Douglas -----	383	586	Sand and gravel, stone.
Elko -----	W	W	Copper, gold, sand and gravel, barite, silver, tungsten, lead, zinc.
Esmeralda -----	13,412	12,441	Lithium, diatomite, sand and gravel, talc, clays, silver, zinc, lead, copper.
Eureka -----	W	25,637	Gold, iron ore, barite, zinc, silver, stone, lead, copper.
Humboldt -----	1,553	3,824	Mercury, stone, sand and gravel, gold, clays, silver, lead.
Lander -----	43,011	41,255	Copper, barite, gold, silver, lead, sand and gravel.
Lincoln -----	9,368	3,988	Gold, zinc, silver, lead, clays, sand and gravel, perlite, copper.
Lyon -----	59,276	63,606	Copper, cement, stone, sand and gravel, diatomite, gypsum.
Mineral -----	W	20	Sand and gravel, stone.
Nye -----	7,126	7,294	Barite, magnesite, petroleum, gold, sand and gravel, fluorspar, clays, pumice, tungsten, silver.
Pershing -----	8,245	5,471	Diatomite, gypsum, iron ore, sand and gravel, perlite, stone, tungsten, clays, gold, silver, zinc, lead.
Storey -----	W	W	Diatomite, sand and gravel, pumice.
Washoe -----	W	W	Sand and gravel, pumice, stone, clays, gold, silver.
White Pine -----	39,742	W	Copper, gold, tungsten, molybdenum, silver, lime, stone, sand and gravel, zinc, lead.
Undistributed ¹ -----	r 54,567	42,549	
Total ² -----	r 258,917	233,683	

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Includes some sand and gravel that cannot be assigned to specific counties; and gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Nevada business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands-----	285.0	305.0	+7.0
Unemployment ----- do-----	26.5	27.0	+1.9
Employment (nonagricultural):			
Mining ----- do-----	4.4	3.5	-20.5
Manufacturing ----- do-----	12.2	12.9	+5.7
Contract construction ----- do-----	12.6	14.8	+17.5
Transportation and public utilities ----- do-----	17.0	17.7	+4.1
Wholesale and retail trade ----- do-----	51.5	56.5	+9.7
Finance, insurance, real estate ----- do-----	10.6	11.3	+6.6
Services ----- do-----	109.2	116.2	+6.4
Government ----- do-----	45.6	46.9	+2.9
Total nonagricultural employment ----- do-----	263.1	279.8	+6.3
Personal income:			
Total ----- millions-----	\$3,893	\$4,368	+12.2
Per capita ----- do-----	\$6,595	\$7,162	+8.6
Construction activity:			
Number of private and public residential units authorized ----- do-----	7,187	13,606	+89.3
Value of nonresidential construction ----- millions-----	\$132.7	\$140.7	+6.0
Value of State road contract awards ----- do-----	\$52.0	\$56.0	+7.7
Shipments of portland and masonry cement to and within the State ----- thousand short tons-----	366	359	-1.9
Mineral production value:			
Total crude mineral value ----- millions-----	\$258.9	\$233.7	-9.7
Value per capita, resident population ----- do-----	\$439	\$383	-12.3
Value per square mile ----- do-----	\$2,342	\$2,114	-9.7

^P Preliminary. ^R Revised.

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

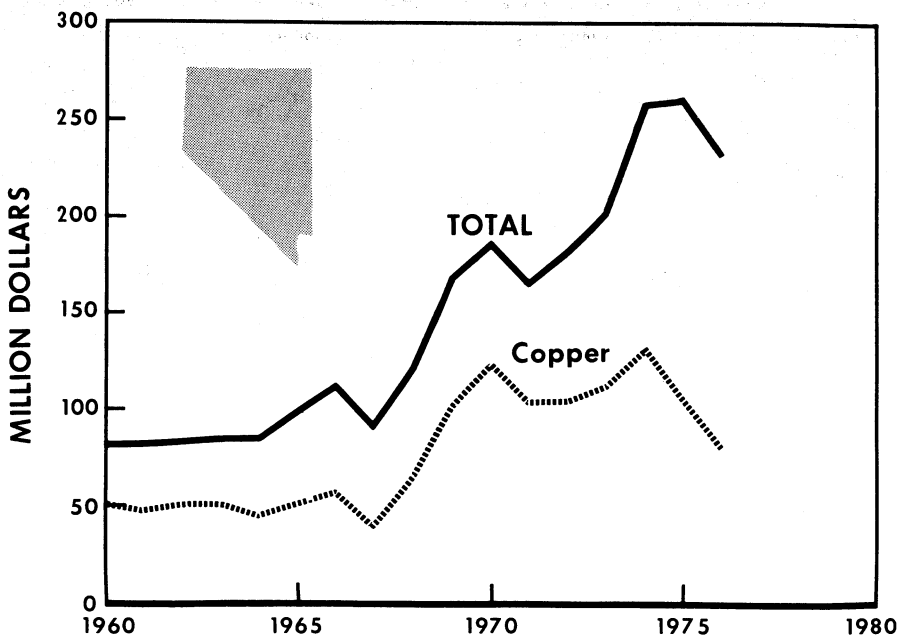


Figure 1.—Value of copper and total value of production in Nevada.

Trends and Developments.—The Cortez gold mine in Lander County was closed early in the summer. Milling at the concentrator stopped in early February and leaching of the low-grade ore ceased at the end of June. Smoky Valley Mining Co. announced that its gold and silver operation near Round Mountain would be in full swing by early December, producing up to 100,000 ounces of gold and silver annually. Gold Development Corp. acquired properties in the Cherry Creek area with emphasis on gold, and attempted some renovating of the former 20th century fuel tungsten mill and contemplated other facilities in an effort to buildup a production program in that district.

Silver King Mines, Inc., obtained an option to purchase the Ward mine and intends to spend \$425,000 by August 1977 to develop the property. Encouraging amounts of copper, zinc, and silver were found in exploratory drilling. There is an estimated \$600 million of ore at the mine. Ladd Enterprises, Inc., continued exploration and development of its Quailey mine (copper-zinc-silver) in Mineral County. An underground drilling program is underway to explore the zone at depth. Underground development is also proceeding on a promising tungsten zone in the same mine.

Standard Resources, Inc., of Carson City entered into a joint venture with Cyprus Mines Corp. of Los Angeles, Calif., involving the Veta Grande mine and mill, about 27 miles south of Carson City. The mine contains a quartz vein about 5,000 feet long with a silica content of potential commercial value and bearing varying amounts of silver. The 2-year agreement between the companies involves a three-phase feasibility study and will be financed by Cyprus for further exploration, development, and operation.

In September, Bunker Hill Co. signed an agreement with St. Patrick Mining Co. of Toronto, Canada to lease the Pan American mine and Caselton concentrator in the Pioche mining district, which is considered one of the top three potential zinc districts in the Western United States. Initial work by Bunker Hill at the mine consisted of a 6-month exploration program to develop adequate ore reserves to support upgrading of the underground and surface facilities, plus a metallurgical testing program to determine if the concentrator recovery can

be improved. The mine is expected to produce 2,000 tons of ore per day, 5 days per week, when in full production. The mill, in full operation, will have a capacity of 1,500 tons of ore feed per day and will operate 7 days per week.

A definitive agreement providing for the merger of The Anaconda Company into a wholly owned subsidiary of the Atlantic Richfield Co. was announced by the chairmen of both companies in June. Anaconda operates the Victoria mine near Currie in southeastern Elko County and the Weed Heights copper mine near Yerington in Lyon County. The merger agreement is subject to the approval of Anaconda shareholders and may be terminated by either company prior to such approval. Completion of the merger also is subject to Governmental rulings and other conditions and approvals. The State Environmental Commission filed a brief in Federal court supporting Kennecott Copper Corp.'s position in the ongoing battle with the Environmental Protection Agency (EPA). The U.S. Supreme Court, however, stood firm on the decision that the Nevada plan for control of air pollution at the eastern Nevada plant does not meet the requirements of the Clean Air Act.

Seven geothermal lease sales were conducted in the State during the year by the Bureau of Land Management (BLM) in Reno. The sales involved 60,994.55 acres in the State, and netted \$757,991.75 for the Agency. The sales were conducted by sealed bids with leases being issued to the highest bidder for each parcel after lease requirements, such as paying advance rentals, were met. When leases are issued, the companies pay yearly rentals plus a royalty on the value of any geothermal energy produced.

Sierra Pacific Power Co. announced plans to begin construction by June of 1977 on two 250,000-megawatt coal-burning electrical powerplants at Valmy, 30 miles east of Winnemucca in Humboldt County. The plants will cost an estimated \$3.5 million and will be put into operation, one at a time, in 1979 and 1980. The North Valmy Power Project, as it is known, will employ 140 workers by the end of 1977, and increase the number to a maximum of 450 in 1979 and 1980. There is a 10-year timetable on the power station construction, and during this decade, an estimated \$23

million is expected to flow into Humboldt and Lander Counties. At the end of the construction period a residual work force of 60 workers will remain.

Uranium exploration continued in the State. Chevron Corp. is actively drilling the old uranium show at the Midnight mine in Humboldt County. Utah International, Inc., has been drilling in the vicinity of the old uranium mine near Mountain City, and Urangesellschaft MbH was working on a uranium prospect about 30 miles north of Reno.

Legislation and Government Programs.—The State of Nevada was paid \$1,349,294 by BLM as its share of mineral and grazing right lease receipts and public land sales during fiscal year 1976. Payments are made twice annually to the State treasury.

BLM is reopening 66,000 acres of land in Pershing and Lander Counties to mining and geothermal leasing. The lands have been closed to leasing since December 1973, when the former Atomic Energy Commission filed an application to temporarily withdraw 86,000 acres at the three sites for geothermal exploration. Proposed new mining regulations by BLM met with strong opposition from the mining industry when they were introduced late in the year. The period for public comment on the regulations was extended into 1977 and public hearings on the regulations were held. BLM opposed private ownership of land in the State under the Desert Land Entry Act. The main complaint of the Agency was that land acquired under this Act seldom is developed and reverts to BLM often in a deteriorated condition.

A Federal judge made permanent his preliminary injunction against the proposed transfer of three game ranges, including the Charles Sheldon Antelope Range in Humboldt and Washoe Counties, to exclusive control by BLM. The judge ruled BLM does not have legal authority to juggle agency control of the ranges. The Senate overturned an Interior Department order on wildlife refuge jurisdiction by BLM and approved a bill that requires all areas within the National Wildlife Refuge System to be administered by the U.S. Fish and Wildlife Service. The U.S. Forest Service cancelled a mineral withdrawal application on 4,900 acres of public

land in the Mt. Jefferson area of Toiyabe National Forest and prohibited small mining operations from staking claims in the area. The land is currently being used as a nature reserve and is being studied for its natural and ecological processes.

The Grand Junction, Colo. office of the Energy Research and Development Administration (ERDA) opened a new field office in July, and at the same time closed a similar operation in Salt Lake City, Utah. The change was made to provide a more central location for investigation efforts required in the Western United States in support of ERDA's ongoing national uranium resource evaluation program. The program includes the development and distribution of uranium resources in the United States, and the identification of areas favorable for the discovery of new uranium districts. Bendix Field Engineering Corp., prime contractor for ERDA's Grand Junction facility, has offices at the same location and will station several geologists there to conduct field studies for ERDA's uranium program.

A survey intended to aid ERDA in assessing uranium resources in seven far Western States moved into the State in July under the direction of scientists from the Lawrence Livermore Laboratory, Livermore, Calif. The survey included a systematic sampling of Nevada's surface waters, ground waters, and stream sediments where uranium is sometimes distributed. Samples that are gathered will be returned to Livermore for analysis. The Mackay School of Mines was awarded a study contract and grant of \$175,156 to report on the uranium potential in the Great Basin as part of the survey.

The Reno Metallurgy Research Center assisted in solving mercury emission problems during the year at the McDermitt mercury mine in northern Humboldt County. A team of Bureau scientists visited the mill to help determine if stack emissions were within EPA requirements and to reduce excessive mercury emissions from the ball mill and flotation cells. The Bureau's field demonstration unit for stripping gold from loaded carbon was operated successfully at a commercial heap-leach cyanidation plant at Eureka.

Cooperative studies between the Bureau and Kennecott Cooper Corp. on the Bureau's electrooxidation process for molyb-

denum extraction from offgrade molybdenite concentrates were completed successfully.

Ten of the Bureau's process developments were cited in the annual review of extractive and process metallurgy appearing in the *Journal of Metals*, March 1976. An article in the spring 1976 issue of the Sul-

phur Institute Journal highlighted results of research at the Bureau of Mines Boulder City (Nev.) Metallurgy Research Laboratory on developing improved sulfur concretes and an article in the summer issue highlighted the Boulder City research on sulfur utilization.

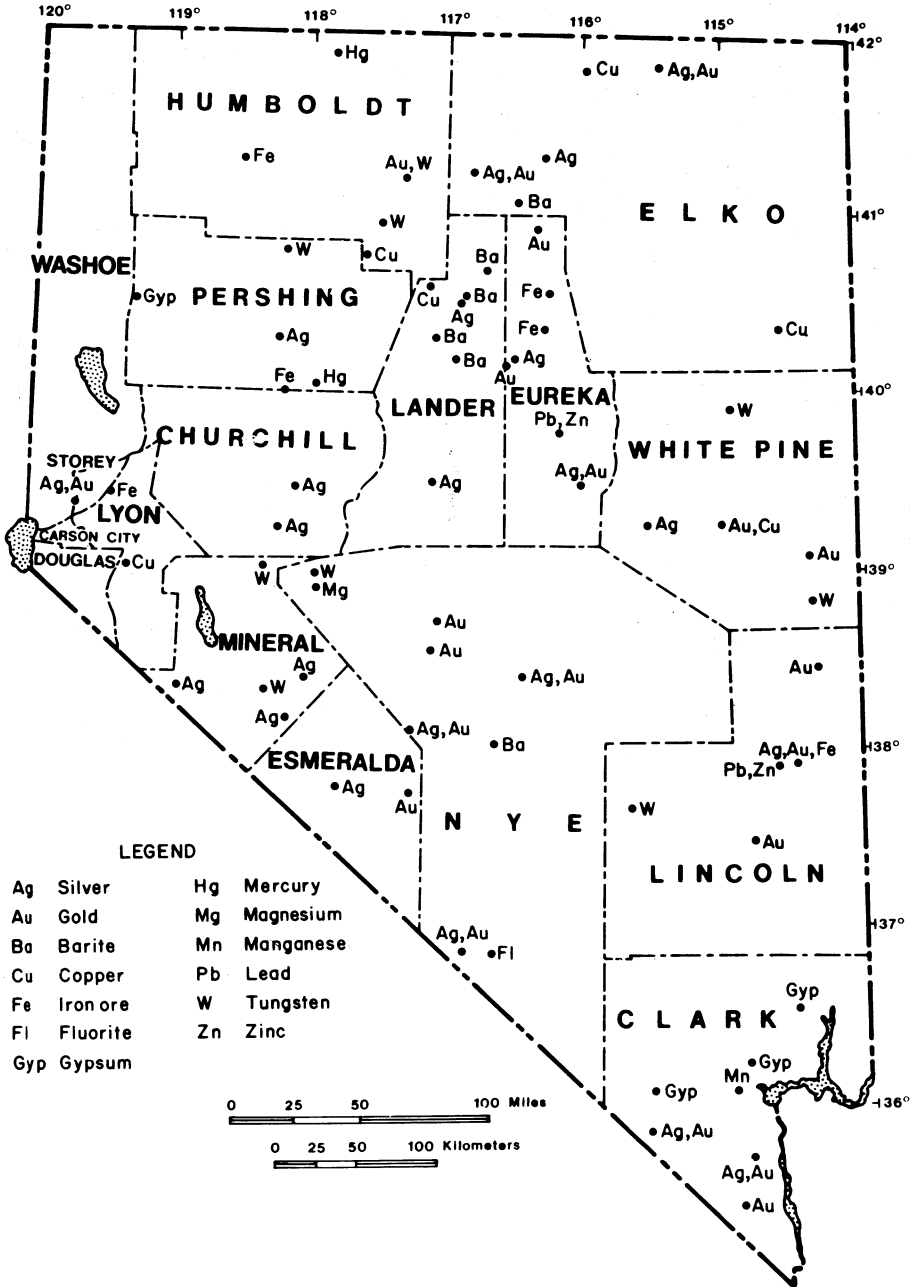


Figure 2.—Generalized map of selected mineral industries in Nevada.

REVIEW BY MINERAL COMMODITIES

METALS

Copper.—Copper output in 1976 declined by 28% from that of 1975. Most of the output came from operations of The Anaconda Company in Lyon and Elko Counties; Kennecott Copper Corp., White Pine County; and Duval Corp., Lander County.

Eighty workers were laid off at The Anaconda Company's Weed Heights facility at the start of the year as a result of the slumping copper market and rising energy costs. In June, Anaconda started underground production at the Victoria mine in

Elko County. Kennecott Copper Corp. closed its operation at McGill in February, laying off 500 workers at the mine and concentrator. The smelter shut down in July when the stockpile of concentrates was depleted, and an additional 225 workers were laid off. The firm reopened in December and 600 of the employees were called back at that time.

Ranchers Exploration & Development Corp. reopened its Big Mike copper leaching operation near Winnemucca in October, and currently the property is producing approximately 3,000 pounds of cement copper daily.

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

County	Mines producing		Material sold or treated ¹ (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1974, total	30	--	23,110,295	298,754	\$47,722,964	872,243	\$4,108,266
1975, total	32	2	21,712,404	332,814	53,746,132	1,608,735	7,110,609
1976:							
Churchill	3	--	1,413	156	19,550	12,385	53,374
Clark	1	1	10	10	1,253	191	831
Elko	8	--	476,124	24,190	3,031,490	88,691	385,807
Esmeralda	1	--	100	--	--	190	827
Eureka	8	--	845,400	187,917	23,549,758	23,854	103,896
Humboldt	3	--	235	50	6,265	141	613
Lander	5	--	1,938,427	53,279	6,676,925	490,638	2,134,276
Lyon	1	--	9,293,863	--	--	--	--
Pershing	3	--	1,065	37	4,637	661	2,876
Washoe	1	--	150	37	4,637	333	1,449
White Pine	3	--	999,141	2,307	289,114	20,633	89,754
Undistributed ²	3	--	197,067	19,979	2,503,769	146,145	635,731
Total	40	1	13,752,995	287,962	36,087,398	783,892	3,409,934
Copper							
		Short tons	Value	Short tons	Value	Short tons	Total value
1974, total		84,101	\$130,020,651	1,785	\$803,091	3,405	\$2,445,034
1975, total		81,210	104,273,989	2,976	1,279,856	5,496	4,287,150
1976:							
Churchill	(3)	441		1	688	1	877
Clark	--	--		(3)	147	--	2,231
Elko	6,005	8,358,314		16	7,512	2	1,246
Esmeralda	(3)	219		2	986	2	1,296
Eureka	3	3,909		35	16,375	321	237,556
Humboldt	--	--		(3)	23	--	6,901
Lander	W	W		W	W	--	+ 8,811,201
Lyon	31,623	44,018,959		--	--	--	44,018,959
Pershing	--	--		(3)	39	(3)	48
Washoe	--	--		--	--	--	7,600
White Pine	7,354	10,236,536		4	2,025	5	3,445
Undistributed ²	13,175	18,339,867		522	241,101	1,108	819,964
Total ⁵	58,160	80,958,245		582	268,896	1,438	1,064,432
							121,788,905

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

¹ Does not include gravel washed.

² Includes Lincoln and Nye Counties combined to avoid disclosing company proprietary data, and items indicated by symbol W.

³ Less than 1/2 unit.

⁴ Incomplete total.

⁵ Data may not add to totals shown because of independent rounding.

Table 5.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ¹	Material sold or treated ² (thousand short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold ³ -----	16	1,296	257,954	47,927	(⁴)	(⁴)	(⁴)
Gold-silver and silver ⁵ -----	15	10	1,158	127,374	1	25	9
Copper ³ -----	4	12,350	28,819	486,325	50,842	8	--
Lead-zinc and zinc ⁵ -----	4	86	21	122,166	6	549	1,430
Total⁶ -----	39	13,742	287,952	783,792	50,850	582	1,438
Other lode material:							
Copper precipitates -----	3	11	--	--	7,310	--	--
Total lode material -----	40	13,753	287,952	783,792	58,160	582	1,438
Placer -----	1	--	10	100	--	--	--
Grand total -----	41	13,753	287,962	783,892	58,160	582	1,438

¹ Detail will not necessarily add to totals shown because some mines produce more than one class of material.

² Does not include gravel washed.

³ Includes material that was leached.

⁴ Less than ½ unit.

⁵ Combined to avoid disclosing company proprietary data.

⁶ Data may not add to totals shown because of independent rounding.

Table 6.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Amalgamation -----	350	35	--	--	--
Cyanidation -----	258,544	156,569	--	--	--
Smelting of concentrates -----	28,665	615,355	38,158	568	1,438
Leaching -----	(¹)	(¹)	12,593	--	--
Direct smelting of:					
Ore -----	393	11,833	99	14	1
Copper precipitates -----	--	--	7,310	--	--
Total lode material -----	287,952	783,792	58,160	582	² 1,438
Placer -----	10	100	--	--	--
Grand total -----	287,962	783,892	58,160	582	1,438

¹ Included in cyanidation.

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

Gold.—Nevada was the Nation's second largest gold producer in 1976, with 27% of the total U.S. output. Gold output in the State decreased 13% in 1976 compared with that of 1975. The four mines that provided most of the total production were the Carlin Gold Mining Co.; Standard Slag Co.'s Atlanta mine; Cortez Gold Mines, whose operations were halted in midsummer; and Idaho Mining Co.'s Windfall

mine. The balance was produced primarily as byproduct gold from copper ores, which accounted for 10% of the lode gold recovered. A total of 40 mines were involved in the production of the metal. Placer gold recovery was insignificant, and only one property was active in Clark County.

Iron Ore.—Usable iron ore production was 18% higher in 1976 than in the previous year. The total output was shipped

as direct shipping grade ore. The ore was produced by Nevada Barth Corp., Eureka County, and by Cooney Bros. in Pershing County.

Lead.—The Pan American lead-zinc mine closed early in the year. It was the only lead-zinc mine in the State.

Mercury.—Production of mercury in 1976 increased above that of 1975. Nevada was again the leading mercury mining State providing 99% of the 1976 national total. The McDermitt Mine, located in Humboldt County, and operated as a joint venture between Mineral Exploration and Placer Amex, was the largest producer in the United States. The other producer in Nevada was the Carlin Gold Mining Co. which continued to produce mercury as a byproduct from its gold mine in Eureka County.

Molybdenum.—Molybdenum was recovered by Kennecott Copper Corp. as a byproduct of treating copper ores at the McGill concentrator, White Pine County. Both production and shipments were substantially higher than those of 1975.

Silver.—Recoverable silver output for the year decreased 51% from that of 1975. The number of lode silver producers increased to 31 from 28 in the previous year. Copper Canyon mine in Lander County was the State's leading producer of recoverable silver. Copper ores yielded 62% of the total lode silver, lead-zinc ores yielded 16%, and all other ores yielded 22%.

Argus Resources, Inc., processed 250 tons of silver ore per day at the Austin mill from the mine dumps on Lander Hill. The tailings contained values in silver with a small amount of gold.

Tungsten.—Fifteen tungsten properties were active during the year. Small quantities of tungsten concentrates were shipped by operators in Churchill, Elko, Nye, Pershing, and White Pine Counties. The tungsten concentrate production increased 200% in 1976. This sharp increase was attributed to Oxbow Tungsten Mines, Inc., starting production at the White Star tungsten mine in the Jarbridge district, Elko County.

Zinc.—Zinc output in 1976 was down 74% from that of 1975. Eleven lode mines accounted for the total zinc production. Over 99% of the total recoverable zinc came from lead and lead-zinc ores.

NONMETALS

Barite.—The quantity of primary barite sold or used by Nevada producers decreased 5% and ground and crushed barite increased 3% in value, compared with 1975 figures. The value of primary ore increased 59% and ground, crushed ore showed an increase of 20%. The number of active mines decreased from 18 to 17 in 1976. NL Industries, Inc., Baroid Div., and Dresser Minerals ground barite in their respective plants at Dunphy, Eureka County, and Battle Mountain, Lander County. Ground barite was also produced by Milchem, Inc., in its Bateman plant near Battle Mountain. Standard Slag, Inc., shipped its crude ore from the Old Soldier mine to its plant near Fallon, for further processing. Almost all of the ground and crushed barite was sold for use in well drilling. FMC Corp. continued to ship crude ore from its Lander County mine to the company plant at Modesto, Calif., for use in manufacturing barium chemicals.

The barite mill at Dunphy laid off employees during the year due to a decline in the need for barite, especially by the oil industry.

Cement.—Portland cement was produced by Nevada Cement Co. in a dry-process plant at Fernley in Lyon County. Shipments increased 3% and the value increased 30% above those of 1975. Most of the cement was used by ready-mix concrete and concrete products manufacturers, building material dealers, and highway contractors.

Clays.—Clays were produced from eight operations in the State, one each in Clark, Esmeralda, Humboldt, Lincoln, Pershing and Washoe Counties, and two in Nye County. Bentonite was mined by Western Talc Co. (R. T. Vanderbilt Co.) from the Toddy pit, Clark County; the Blanco pit near Mina, Esmeralda County; and the New Discovery pit near Beatty in Nye County. The K. W. Snyder Co. mined bentonite at the Hi Hopes pit 15 miles west of Winnemucca in Humboldt County. Soil conditioner was produced by Good Earth Corp. near Panaca in Lincoln County. Industrial Minerals Ventures, Inc., mined bentonite in the Amargosa area 10 miles south of Lathrop Wells, Nye County. Common clay was obtained from a deposit near

Flanigan, Washoe County, by Nevada Cement Co. for use at the company's cement plant in Lyon County. Viking Minerals, Inc., mined kaolin near Lovelock in Pershing County. Clay sold or used during the year increased both in quantity and value above the 1975 figures.

Diatomite.—Sales of prepared diatomite increased 15% in quantity and 24% in value compared with the figures for 1975. No sales of crude materials were reported. As in 1975, five deposits were mined, one each in Churchill, Esmeralda, Lyon, Pershing, and Storey Counties. Eagle-Picher Industries, Inc., remained the largest Nevada producer from its Celaton mine in Pershing County, and the Tunnel Hill mine in Storey County. Cyprus Industrial Minerals Co., the second largest producer, supplied diatomite from its mine in Churchill County to its plant at Fernley in Lyon County. Product sales were mainly for filtration, filler, lightweight aggregate, and insulation.

Fluorspar.—Production and shipments of metallurgical-grade fluorspar for the year were about the same as in 1975. The only producer in the State was J. Irving Crowell, Jr., in Nye County.

Gypsum.—Crude gypsum production increased 42% in quantity over that of 1975. The output was used in Nevada and California plants for making plaster and board products and as a retarder in portland cement. Gypsum was mined at United States Gypsum Co.'s Empire quarry in Pershing County for use in the company plant at Gerlach, Washoe County. In Clark County, The Flintkote's Co.'s Blue Diamond mine and Pabco's Apex mine mined gypsum for use at their respective Blue Diamond and Apex plants, and for shipment to plants in California. Flintkote, Pabco, and U.S. Gypsum calcined gypsum in Clark and Washoe Counties.

Lime.—Lime output rose 20% over that of 1975. The increase was chiefly attributed to the chemical industry. United States Lime Div. of The Flintkote Co. operated two plants in Clark County, producing quicklime at Apex, and both quicklime and hydrated lime at Henderson. Morrison & Weatherly Chemical Products Co. produced lime at McGill, White Pine County, primarily for use in the concentration of copper ores at the Kennecott Copper Corp. plant in McGill.

Lithium Compounds.—The output of lithium carbonate from the Silver Peak facility of Foote Mineral Co. in Esmeralda County decreased 10% compared with that of 1975. The major use of lithium carbonate continued to be as a cell additive in aluminum potlines.

Magnesite and Brucite.—Basic, Inc., near Gabbs, Nye County, was the sole producer of magnesite. A high percentage of the crude magnesite output was consumed by the company in making caustic-calcined and refractory magnesias as well as various refractory products. The major consuming industries for caustic-calcined magnesias were oxychloride and oxysulfate cements, chemicals, synthetic rubber, rayon, and fertilizer. Production and sales were slightly less than those of 1975. No brucite was mined, but shippers of the stockpiled mineral, previously beneficiated, were made by Basic, Inc.

Perlite.—All of the crude perlite in Nevada was produced by two companies; United States Gypsum Co. operated the Pearl Hill quarry in Pershing County, and Delamar-Mackie Perlite worked the Mackie claims in Lincoln County. Some of the crude perlite from the Pearl Hill quarry was expanded and used in the producer's Washoe County wallboard plant.

Pumice (Volcanic Cinder).—Crude pumice, pumicite, and volcanic cinder production was higher in 1976 than that of 1975. The increase was due primarily to greater demand for concrete aggregate. The material was used for concrete admixture, aggregate, landscaping, and roofing. Volcanic cinder from Savage Construction Co., Inc.'s Cinderlite Aggregates property, Carson City, was prepared for use in concrete aggregates road construction, landscaping, and roofing. Pumice was mined by Construction Aggregates Co. in Churchill County, and Cind-R-Lite Block Co. of Nye County mined volcanic cinder from the Cinder Cove deposit southeast of Beatty, for concrete aggregate and landscaping. Pumicite from the Naturalite group of claims in Storey County was acquired by Alaska Interstate Co. during the year. Pumice from the Rilite Aggregate Co. property, Washoe County, was prepared for use in concrete aggregates.

Salt.—The sole salt producer in the State was Huck Salt Co. which leased and operated the Leslie Salt Co. solar evapora-

tion plant in Churchill County. All of the production was used in Nevada, primarily for ice control on roads. The remainder was used in the meat packing, tanning, casing, and dairy industries, in feed mixes, and by water conditioning service companies and metal processors.

Sand and Gravel.—Output of sand and gravel increased 20% above the 1975 production. There were 95 active operations during the year, 13 more than in 1975.

Stone.—About 1.9 million tons of stone was quarried from 11 locations in 1976, compared with 1.8 million tons from the

same number of locations in 1975. The increase was due mostly to a larger output of limestone. Most of the limestone was converted to lime or used as a metallurgical flux, primarily in the smelting of copper. Public works crews and contractors produced limestone and quartzite in several counties for use as riprap, roadbase, and concrete aggregate.

Talc.—The output of talc in Nevada came from the Oasis mine in Esmeralda County, and decreased 7% compared with that produced in 1975. All shipments went to out-of-State grinding mills.

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

Use	1976	
	Quantity (thousand short tons)	Value (thousands)
Construction:		
Sand	2,667	\$4,295
Gravel	6,449	12,225
Industrial:		
Sand	555	3,587
Gravel	W	W
Total	9,671	¹ 20,106

W Withheld to avoid disclosing company proprietary data; included with "Construction gravel."
¹ Data do not add to total shown because of independent rounding.

Table 8.—Nevada: Construction aggregate (blended sand and gravel) sold or used commercially by producers
 (Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,696	7,872	2,687	5,538
Concrete products (cement blocks, bricks, pipes, etc.)	155	279	627	1,081
Asphaltic concrete aggregates and other bituminous mixtures	535	795	1,937	4,308
Roadbase and coverings	¹ 661	871	2,960	4,854
Fill	650	532	752	867
Other uses	W	W	122	422
Total ²	4,697	10,349	9,116	16,519

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

¹ Includes processed material only for 1975.

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

MINERAL FUELS

Petroleum.—The Nevada Oil and Gas Conservation Commission issued 16 well drilling permits in 1976. Seven of the wells drilled, one each in Churchill and Nye Counties, two in White Pine County, and three in Elko County, were dry.

The Eagle Springs oilfield continued to be an active field with an average of eight wells producing. Northwest Energy Co.

revealed a new oilfield adjacent to the Eagle Springs area in a southwesterly direction. The company announced that pumping tests on the new Trap Springs No. 1 well showed favorable results. The well produced 625 barrels per day, valued at about \$8,000 when put into production in December.

A new oilfield, adjacent to the southwest of the Eagle Spring oilfield, was discovered near the end of the year.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
All Minerals, Inc -----	Box 63 Round Mountain, Nev. 89045	Surface mine -----	Nye.
Dresser Minerals -----	Box 375 Battle Mountain, Nev. 89820	----do -----	Lander.
FMC Corp -----	Box 531 Battle Mountain, Nev. 89820	----do -----	Do.
IMCO Services, Inc -----	Box 445 Battle Mountain, Nev. 89820	Plant -----	Do.
Milchem, Inc -----	Box 272 Battle Mountain, Nev. 89820	Surface mine -----	Do.
The Milwhite Co., Inc ----	Box 1909 Elko, Nev. 89801	----do -----	Do.
NL Industries, Inc -----	Box 1675 Houston, Tex. 77001	----do -----	Elko.
Standard Slag, Inc -----	Box 10477 Reno, Nev. 89510	----do -----	Nye.
Tom Norris Mining Co ----	Box 231 Battle Mountain, Nev. 89820	----do -----	Lander.
Cement:			
Nevada Cement Co. ¹ -----	Fernley, Nev. 89408 -----	Plant -----	Lyon.
Clays:			
Centex Corp -----	Fernley, Nev. 89408 -----	Pit -----	Pershing.
Good Earth Corp -----	726 East Sahara Ave. Las Vegas, Nev. 89104	Surface mine -----	Lincoln.
Industrial Mineral Ventures, Inc. -----	Box 237 Lathrop Wells, Nev. 89020	----do -----	Nye.
Kelly-Moore Paint Co ----	1015 Commercial St. San Carlos, Calif. 94070	Pit -----	Pershing.
Viking Minerals, Inc -----	Box 546 Oakdale, Calif. 95361	Surface mine -----	Do.
Western Talc Co -----	Box 398 Beatty, Nev. 89003	Surface mines ----	Clark, Esme- ralda, Nye.
Copper:			
The Anaconda Company ² --	Box 1000 Weed Heights, Nev. 89443	Surface mine -----	Lyon.
Do -----	Box 65 Wendover, Utah 84083	Open pit -----	Elko.
Duval Corp. ³ -----	Box 451 Battle Mountain, Nev. 89820	Surface mine -----	Lander.
Kennecott Copper Corp. ⁴ --	McGill, Nev. 89318 -----	----do -----	White Pine.
Diatomite:			
Cyprus Industrial Minerals Co. -----	Box 455 Fernley, Nev. 89408	----do -----	Churchill.
Eagle-Picher Industries, Inc. -----	Box 1869 Reno, Nev. 89505	----do -----	Pershing and Storey.
Fluorspar:			
J. Irving Crowell, Jr ----	Box 96 Beatty, Nev. 89003	Underground mine.	Nye.
Gold:			
Carlín Gold Mining Co. ⁵ --	Box 979 Carlín, Nev. 89822	Surface mine -----	Elko and Eureka.
Cortez Gold Mines -----	Cortez, Nev. 89821 -----	----do -----	Lander.
Idaho Mining Co -----	Box 328 Eureka, Nev. 89316	----do -----	Eureka.
Smoky Valley Mining Co --	Box 480 Round Mountain, Nev. 89045	----do -----	Nye.
Standard Slag Co -----	Box 97 Pioche, Nev. 89043	----do -----	Lincoln.
Gypsum:			
The Flintkote Co. ⁶ -----	Box 127 Henderson, Nev. 89015	----do -----	Clark.
Pabco -----	Box 14186 Las Vegas, Nev. 89114	----do -----	Do.
United States Gypsum Co. ⁷ --	Empire, Nev. 89045 -----	----do -----	Pershing.

See footnotes at end of table.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
Cooney Bros -----	Box 568 Lovelock, Nev. 89419	Surface mine ----	Pershing.
Nevada Barth Corp -----	Box 425 Carlin, Nev. 89822	----do -----	Eureka.
Lead:			
Mt. Hope Mines, Inc -----	Box 218 Eureka, Nev. 89316	Underground mine..	Do.
Pan American Mine, The Bunker Hill Co. ⁸	Box 276 Pioche, Nev. 89043	Surface mine ----	Lincoln.
Lime:			
Morrison & Weatherly Chemical Products Co. ⁹	East Ely, Nev. 89315 -----	Rotary kilns ----	White Pine.
Lithium:			
Foote Mineral Co -----	Silverpeak, Nev. 89047 ----	Dry lake brines ---	Esmeralda.
Magnesite:			
Basic, Inc. ¹⁰ -----	Box 4 Gabbs, Nev. 89409	Surface mine ----	Nye.
Mercury:			
McDermitt Mine -----	Box 101 McDermitt, Nev. 89421	Open pit -----	Humboldt.
Perlite:			
Delamar-Mackie Perlite ---	Box 217 Pioche, Nev. 89043	Underground mine..	Lincoln.
Petroleum:			
Ely Crude Oil -----	Via Tonopah Stage Ely, Nev. 89301	Wells -----	Nye.
Northwest Exploration Co -	Box 90 Farmington, N. Mex. 87401	----do -----	Do.
Toiyabe Oil, Inc -----	Box 549 Tonopah, Nev. 89049	----do -----	Do.
Western Oil Lands, Inc ---	380 Linden St. Reno, Nev. 89502	----do -----	Do.
Pumice:			
Cind-R-Lite Block Co ----	3333 Cinder Lane Las Vegas, Nev. 89103	Open pit -----	Do.
Rilite Aggregate Co -----	Box 5665 Reno, Nev. 89503	Surface mine ----	Washoe.
Savage Construction Co., Inc.	Box 970 Carson City, Nev. 89701	Open pit -----	Carson City.
Salt:			
Huck Salt Co -----	Route 2, Box 33 Fallon, Nev. 89406	Solar evaporation plant.	Churchill.
Sand and gravel:			
Diamond Construction Co -	4020 East Cheyenne Ave. Las Vegas, Nev. 89030	Pit -----	Clark.
Hess Rock Products Co ---	Route 1 McCarran Ranch Sparks, Nev. 89431	Pit -----	Washoe.
Nevada Aggregates and Asphalt.	Box 7424 Reno, Nev. 89502	Pit -----	Do.
Nevada Rock & Sand Co ---	Box 2775 Huntridge Station Las Vegas, Nev. 89101	Pit -----	Clark.
Robert L. Helms Construc- tion & Development.	Drawer 608 Sparks, Nev. 89431	Pit -----	Washoe.
Southern Nevada Paving, Inc.	3555 Polaris Las Vegas, Nev. 89101	Pit -----	Clark.
Stewart Bros. Co -----	----do -----	Pit -----	Nye.
W.M.C. Engineering -----	Box 1301 Elko, Nev. 89801	Pit -----	Elko.
W.M.K. Transit Mix, Inc -	1606 Industrial Rd. Las Vegas, Nev. 89102	Pit -----	Clark.
Wells-Cargo, Inc. ¹¹ -----	Box 14037 Las Vegas, Nev. 89114	Pit -----	Do.
Tungsten:			
Boundy Mining, Inc -----	Box 173 Ely, Nev. 89301	Surface mine ----	White Pine.
Oxbow Tungsten Mine, Inc.	Box 175 Mountain City, Nev. 89831	----do -----	Elko.
Union Carbide Corp -----	Box 307 Alamo, Nev. 89001	Underground mine..	Lincoln.

¹ Also clays and stone.

² Also gold and silver.

³ Also gold, silver, and lead.

⁴ Also gold, silver, and molybdenum.

⁵ Also mercury.

⁶ Also lime and stone.

⁷ Also perlite.

⁸ Also silver and zinc.

⁹ Also crude petroleum.

¹⁰ Sole magnesite producer in the United States.

¹¹ Also stone.

The Mineral Industry of New Hampshire

This chapter has been prepared under a cooperative agreement 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 minerals except fuels.

By William R. Barton ¹ and Glenn W. Stewart ²

The value of minerals produced in New Hampshire in 1976 was \$17.6 million compared with \$17.1 million in 1975. The increase of 3% in value was due to general inflationary pressures in the economy as well as increased production of sand and gravel. Sand and gravel, and stone

represented more than 99% of the mineral wealth produced by New Hampshire miners. No metallic minerals or mineral fuels were produced.

¹ State Liaison Officer, Bureau of Mines, Newmarket, N.H.

² State geologist, Department of Resources and Economic Development, Durham, N.H.

Table 1.—Mineral production in New Hampshire ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel—thousand short tons—	5,150	\$9,077	² 6,180	² \$10,409
Stone -----do-----	1,519	7,938	742	7,032
Value of items that cannot be disclosed:				
Clays, gem stones, sand and gravel (industrial, 1976) -----	XX	92	XX	138
Total -----	XX	17,107	XX	17,579
Total 1967 constant dollars -----	XX	6,769	XX	^p 6,320

^p Preliminary. 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in New Hampshire, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Belknap -----	W	W	Sand and gravel.
Carroll -----	\$1,831	\$1,494	Do.
Cheshire -----	489	979	Do.
Coos -----	487	447	Do.
Grafton -----	W	W	Sand and gravel, stone.
Hillsborough -----	7,086	6,683	Stone, sand and gravel.
Merrimack -----	2,606	3,678	Sand and gravel, stone.
Rockingham -----	1,772	W	Sand and gravel, stone, clays.
Strafford -----	W	W	Sand and gravel, clays.
Sullivan -----	170	168	Sand and gravel.
Undistributed ¹ -----	2,667	4,132	
Total ² -----	17,107	17,579	

W Withheld to avoid disclosing individual company confidential 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 New Hampshire business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	358.1	387.0	+ 8.1
Unemployment -----do-----	23.2	25.0	+ 7.8
Employment (nonagricultural):			
Mining -----do-----	.4	.4	--
Manufacturing -----do-----	85.1	94.3	+ 10.8
Contract construction -----do-----	12.9	14.0	+ 8.5
Transportation and public utilities -----do-----	12.0	12.1	+ .8
Wholesale and retail trade -----do-----	64.2	67.7	+ 5.5
Finance, insurance, real estate -----do-----	14.1	15.0	+ 6.4
Services -----do-----	56.1	58.6	+ 4.5
Government -----do-----	47.8	49.9	+ 4.4
Total nonagricultural employment -----do-----	292.6	312.0	+ 6.6
Personal income:			
Total -----millions--	\$4,400	\$4,942	+ 12.3
Per capita -----do-----	\$5,420	\$6,010	+ 10.9
Construction activity:			
Number of private and public residential units authorized--	3,631	5,995	+ 65.1
Value of nonresidential construction -----millions--	\$28.2	\$60.9	+ 116.0
Value of State road contract awards -----do-----	\$45.0	\$60.0	+ 33.3
Shipments of portland and masonry cement to and within the State -----thousand short tons--	220	249	+ 13.2
Mineral production value:			
Total crude mineral value -----millions--	\$17.1	\$17.6	+ 2.9
Value per capita, resident population -----do-----	\$21	\$21	--
Value per square mile -----do-----	\$1,839	\$1,889	+ 2.7

^p Preliminary.

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

Table 4.—Worktime and injury experience in the New Hampshire mineral industry in 1976¹

	Men	Manhours	Fatal injuries	Fatal frequency rate	Non-fatal disabling injuries	Non-fatal disabling frequency rate	Nondisabling injuries	Nondisabling frequency rate
Sand and gravel:								
Surface -----	278	460,523	--	--	7	15.20	1	2.17
Office -----	60	71,653	--	--	--	--	--	--
Total -----	338	532,176	--	--	7	13.15	1	1.88
Stone:								
Surface -----	65	145,081	--	--	9	62.06	--	--
Mill -----	120	264,865	--	--	13	49.08	--	--
Office -----	35	76,219	--	--	1	13.12	--	--
Total -----	220	486,115	--	--	23	47.31	--	--
Clay:								
Surface -----	4	4,563	--	--	--	--	--	--
Mill -----	30	31,630	--	--	2	63.23	--	--
Office -----	3	1,864	--	--	--	--	--	--
Total -----	37	38,057	--	--	2	52.55	--	--
Gypsum:								
Mill -----	10	27,263	--	--	1	36.68	--	--
Office -----	1	416	--	--	--	--	--	--
Total -----	11	27,679	--	--	1	36.68	--	--
State total:								
Surface -----	347	610,117	--	--	16	26.22	1	1.64
Mill -----	160	323,758	--	--	16	49.42	--	--
Office -----	99	150,152	--	--	1	6.66	--	--
Grand total -----	606	1,084,027	--	--	33	30.44	1	.92

¹ Data supplied by the Mining Safety and Health Administration, U.S. Department of Labor.

Compared with the national per capita average of 40,000 pounds of new mineral materials required annually, New Hampshire has indigenous production of approximately 15,500 pounds per capita. The State presently is fully self-sufficient only in sand and gravel and most stone varieties but must import most nonmetallic minerals and all required metals and mineral fuels from other States and foreign countries. Approximately 182 trillion Btu of energy is used annually in New Hampshire and 94% of it is derived from mineral fuels. The source of the State's energy is 78% petroleum products including gasoline, 13% coal, 3% natural gas, and only 6% from hydropower. The first nuclear powerplant in New Hampshire is under construction at Seabrook. Many New Hampshire industries are directly dependent upon mineral-derived raw materials for continued operations. Approximately 10% of all manufacturing employment is in the fields of primary or fabricated metal products, chemical or allied industries, and stone, clay, or glass products. In turn, a plethora of other New Hamp-

shire industries use the products from the above classes of industry as raw materials in their own plants. Almost all of the basic mineral raw materials to support the diverse manufacturing economy are imported, and costs of raw materials represent almost 50% of the value of all New Hampshire industrial shipments.

Coastal zone management programs were being devised by all of the New England coastal States as mandated by Federal coastal zone legislation. The plans impacted on present and future mining with varying severity but in all cases offered new restrictions or additional operational requirements that in the long run would lessen the availability at a reasonable price of minerals essential to the New England economy.

A visitor guide to mining and mineral operations in the northeast, including New Hampshire, was published.³ The booklet described active and abandoned mining

³ Bureau of Mines. Mining and Mineral Operations in the New England and Mid-Atlantic States. A Visitors Guide. SP 10-76, 1976, 72 pp.

sites and camps that could be visited or easily viewed from major highways.

An article by William B. Walker on New Hampshire mineral potential was pub-

lished in the December issue of *The New Englander* magazine. The seven-page review was entitled "There's Wealth In Them Thar Hills."

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—There are no cement plants in New Hampshire. In 1976, domestic producers reported shipping 236,239 tons of finished portland cement and 12,976 tons of prepared masonry cement into the State; 1975 figures were 208,964 tons and 11,399 tons, respectively.

Clays.—W. S. Goodrich, Inc., and Kane-Gonic Brick Corp. mined common clay to manufacture common and face brick. Output decreased compared with that of 1975. The clay was mined and manufactured into brick in Rockingham and Strafford Counties.

Diatomaceous Earth.—Franklin Yoffe and Peter Fuller of Massachusetts applied for a mining permit to dredge and process 34 million cubic yards of diatomaceous earth from State-owned Lake Umbagog. If approved, the mining plan would result in production of approximately 1.5 million tons of finished diatomite during the 20-year project life. The last attempt to obtain a mining permit in 1970-72 was defeated under pressure from environmentalist groups. Commissioner Gilman of the Department of Resources and Economic Development said denial of the previous application would not prejudice the fate of any new application.

Gem Stones.—The value of gem stones and mineral specimens collected was substantial in 1976. The old Ruggles mine, in a pegmatite near Grafton, was operated as a commercial tourist attraction. It was a center for mineral collectors as well as for those just wishing to tour the mine. Collecting of bright green fluorite at the old Will Wise mine in Westmoreland was also popular, along with searching for amazonite, topaz, and smoky quartz in Conway granite areas. Some old mines in the Amonoosuc goldfields are also open to collectors and tourists.

Gypsum.—National Gypsum Co. calcined gypsum from Canada in its Portsmouth plant in Rockingham County. Output increased substantially. The plant was

one of the only two gypsum plants active in New England. (The other was United States Gypsum Co. at Charlestown, Mass.)

Lime.—There are no lime plants in New Hampshire. Consumption of lime, as measured by shipments of domestic lime into the State, was 8,284 tons in 1976. Much agricultural liming was done in the form of ground limestone and is not reflected in the lime consumption total.

Mica.—Mica was not produced in New Hampshire in 1976, and none of the mica mines in the State have been active for many years.

Two firms, the Macallen Co., Inc. (division of Essex International, Inc.), at Newmarket and Concord Mica Corp., Penacook, fabricated mica purchased elsewhere.

Perlite.—National Gypsum Co. expanded perlite for plaster aggregate at Portsmouth, Rockingham County. The crude perlite was shipped into New Hampshire from Western States.

Sand and Gravel.—Production of sand and gravel increased 20% in tonnage and increased 15% in value compared with that of 1975. A total of 45 pits were operated in 10 counties by 35 operators or operating subsidiaries. The counties recording the highest production in 1976 were Merrimack and Hillsborough; they accounted for 35% of the total sand and gravel output. The leading commercial producers were Manchester Sand, Gravel & Cement Co.; Tilton Sand & Gravel, Inc.; J. J. Cronin Co.; and Iafolla Industries, Inc. The New Hampshire Department of Public Works and Highways was another important producer, operating eight pits.

The February 1976 issue of *Rock Products* magazine featured an article on two of Arthur Whitcomb's sand and gravel plants. The two operations described were those at Twin Mountain and at North Conway. Because of severe winter conditions, the two pits work only from May through October, relying on large stockpiles to make it through the ice and snow season.

Table 5.—New Hampshire: Construction sand and gravel sold or used

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	3,336	\$3,754	\$1.13
Gravel -----	2,845	6,655	2.34
Total -----	¹ 6,180	10,409	1.68

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

Table 6.—New Hampshire: Construction sand and gravel sold or used by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) ---	1,613	\$3,734	\$2.31
Concrete products (cement blocks, bricks, pipe, etc.) ----	353	713	2.02
Asphaltic concrete aggregates and other bituminous mixtures -----	1,227	2,425	1.98
Roadbases and coverings -----	1,359	1,515	1.11
Fill -----	1,397	1,681	1.20
Other uses -----	232	340	1.47
Total ¹ -----	6,180	10,409	1.68

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

Stone.—Stone production decreased 51% in tonnage and 11% in value in 1976. Dimension granite was quarried in Hillsborough and Merrimack Counties for dressed architectural, construction, monumental stone, and curbing. Fabrication plants were also operated in both counties. Among the States, New Hampshire ranked fourth in the output of dimension granite.

Crushed traprock was produced by Lebanon Crushed Stone, Inc., in Grafton County, and crushed metavolcanics was produced by Iafolla Industries, Inc., in Rockingham County. Manchester Sand,

Gravel & Cement Co. produced crushed granite in Hillsborough County. The New Hampshire Department of Public Works and Highways crushed granite in Hillsborough County for road aggregate.

Total stone production was 742,000 tons valued at more than \$7 million in 1976 compared with production of 1.5 million tons valued at \$7.9 million in 1975. Output of dimension stone was more than 60,000 tons valued at \$5.27 million. Crushed stone production was approximately 679,000 tons valued at \$1.76 million.

Table 7.—New Hampshire: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	677	1,853	417	939
Bituminous aggregate -----	494	1,074	W	W
Riprap and jetty stone -----	81	71	W	W
Fill -----	71	107	--	--
Other uses ² -----	181	377	261	820
Total ³ -----	1,454	2,981	679	1,759

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

¹ Includes granite and traprock.

² Includes concrete aggregate, roadstone, surface treatment aggregate, filter stone (1976), and terrazzo and exposed aggregate (1975).

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

MINERAL FUELS

Statistics on New Hampshire fuel consumption are published annually by the New England Fuel Institute in the March issue of *Yankee Oilman*. Data for 1974 were published in March 1976.

The Bureau of Mines published two reports detailing fuels and energy data by individual Eastern States including New Hampshire.⁴ Another Bureau of Mines report published the results of a June 1976 survey of planned or proposed coal mines, coal and noncoal conversion plants, oil refineries, uranium enrichment facilities, and related infrastructures.⁵

Petroleum.—C. H. Sprague Oil Co., division of Axel Johnson Co., applied for permission to add No. 2 heating oil to the product mix coming from its ecoseparator in Newington. Presently the plant produces No. 4 oil and naphtha. Reports continued of possible interest in Rochester as the site for a future petroleum refinery.

A planned gas pipeline from St. John, New Brunswick, to Pennsylvania, a Tencoco project, would cross the southern portion of New Hampshire. Tentatively, a tap into the proposed pipeline was planned near Concord.

METALS

Base Metals.—Considerable prospecting occurred in old copper and zinc mining districts of New Hampshire. Standard Metals Corp. announced that it had completed 27 diamond drill holes on the Higgins property near West Milan. At yearend the firm was weighing the decision on proceeding with development of the zinc-copper ore body. Tentative plans

include provision for recovery of sulfuric acid as a byproduct.

Iron and Steel.—Joy Manufacturing Co. in Claremont began construction of the largest, most modern casting facility in New England. The \$12 million foundry will be able to make steel castings up to 7,000 pounds in weight and will provide employment for 200 persons.

Uranium and Thorium.—Bureau of Mines research on Conway Granite samples at its Tuscaloosa Metallurgy Research Center successfully separated the material into three products: A glass-quality silica, ceramic-grade feldspar, and a mica fraction containing 0.03% to 0.04% U₃O₈ equivalent in the form of uranium and thorium. Research was proceeding with sample size increased from the original 80 pounds up to 2 tons. The work was being conducted in cooperation with the New Hampshire State Geologist and the Governor's Council on Energy and Mineral Resources. The project was started in response to a request by Gov. Meldrim Thomson, Jr. Several private companies were actively prospecting for uranium in areas underlain by the Conway Granite.

Zirconium.—Ionarc, Inc. (division of Ionarc Smelters, Ltd.), operated a plant at Bow which converted Australian zircon to zirconium and zirconium dioxide by the Ionarc process.

⁴ Crump, L. H. *Historical Fuels and Energy Consumption Data, 1960-72, United States and Census Districts East of the Mississippi*. BuMines IC 8704, 1976, 456 pp.

—. *Fuels and Energy Data: United States by States and Census Divisions, 1973*. BuMines IC 8722, 1976, 112 pp.

⁵ Staff, *Eastern Field Operations Center. Projects to Expand Fuel Sources in Eastern States*. BuMines IC 8725, 1976, 114 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
W. S. Goodrich, Inc	Epping, N.H. 03042	Pit	Rockingham.
Kane-Gonic Brick Corp	Gonic, N.H. 03867	Pit	Strafford.
Gypsum (calcined):			
National Gypsum Co. ¹	325 Delaware Ave. Buffalo, N.Y. 14202	Plant	Rockingham.
Sand and gravel:			
R. S. Audley, Inc	Route 3A, Bow, N.H. 03302	Pit	Merrimack.
Alvin J. Coleman & Son, Inc.	Route 16 Conway, N.H. 03818	Pit	Carroll.
J. J. Cronin Co	Box 176 North Reading, Mass. 01864	Pit	Hillsborough.
Iafolla Industries, Inc. ²	Peverly Hill Rd. Portsmouth, N.H. 03801	Pit	Rockingham and Strafford.
Hudson Sand and Gravel	85 Greely St. Hudson, N.H. 03051	Pit	Hillsborough.
Keene Sand & Gravel, Inc.	725 Main St. Keene, N.H. 03431	Pit	Cheshire.
Manchester Sand, Gravel & Cement Co. ³	Box 415 Hookset, N.H. 03106	Pit	Merrimack.
New Hampshire State Public Works & Highway Department.	85 Loudon Rd. Concord, N.H. 03301	Pits	Statewide.
Ossipee Aggregates Corp	Ossipee, N.H. 03864	Pit	Carroll.
Tilton Sand & Gravel, Inc.	Tilton, N.H. 03276	Pit	Belknap.
F. W. Whitcomb Construction Corp.	Box 429 Bellows Falls, Vt. 05101	Pit	Cheshire.
Stone:			
Granite, dimension:			
Kitledge Granite Corp.	Armory Rd. Milford, N.H. 03055	Quarry	Hillsborough.
Maine-New Hampshire Granite Co.	P.O. Box 1122 Lowell, Mass. 01852	do	Do.
John Swenson Granite Co., Inc.	North State St. Concord, N.H. 03301	do	Merrimack.
Traprock: Lebanon Crushed Stone, Inc.	Plainfield Rd. West Lebanon, N.H. 03784	do	Grafton.

¹ Also expanded perlite.² Also traprock.³ Also crushed granite.

The Mineral Industry of New Jersey

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New Jersey Division of Natural Resources, Bureau of Geology and Topography, for collecting information on all minerals except fuels.

By William Kebblish ¹

The value of New Jersey's mineral production totaled \$119.9 million, 3% less than that of 1975. Sand and gravel, one of the State's two major mineral products, decreased less than 1% in value. Stone, the other leading commodity decreased 8%. Zinc, which ranks a distant third, remained little changed in output value. Sussex was the leading mineral-producing county and was followed, in descending order of value, by Somerset, Cumberland, Passaic, Morris, and Ocean. Mineral production was reported in all counties except Salem.

Legislation and Government Programs.
—The New Jersey Department of Environ-

mental Protection (DEP) issued interim land use guidelines for the State's coastal zone, including specifications for high rise apartments. DEP also declared a moratorium on the issuance of Coastal Area Facility Revenue Act (CAFRA) permits for the construction of residential developments or other heavily occupied facilities near nuclear facilities. An Act, approved October 23, 1975, pertained to application for construction permits, 90-day processing of the application with extensions under

¹ State Liaison Officer, Bureau of Mines, Harrisburg, Pa.

Table 1.—Mineral production in New Jersey ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons--	67	\$372	61	\$331
Gem stones -----	NA	16	NA	17
Peat ----- thousand short tons--	29	686	22	568
Sand and gravel ----- do	13,012	39,640	12,420	39,439
Stone ² ----- do	11,821	42,381	11,234	39,012
Zinc (recoverable content of ores, etc.) ----- short tons--	31,105	24,262	33,767	24,987
Value of items that cannot be disclosed:				
Lime, magnesium compounds, manganiferous residuum, marl (greensand), stone (dimension), and titanium concentrate (ilmenite) -----	XX	16,345	XX	15,532
Total -----	XX	123,702	XX	119,886
Total 1967 constant dollars -----	XX	48,949	XX	^p 43,099

^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 dimension stone; included with "Value of items that cannot be disclosed."

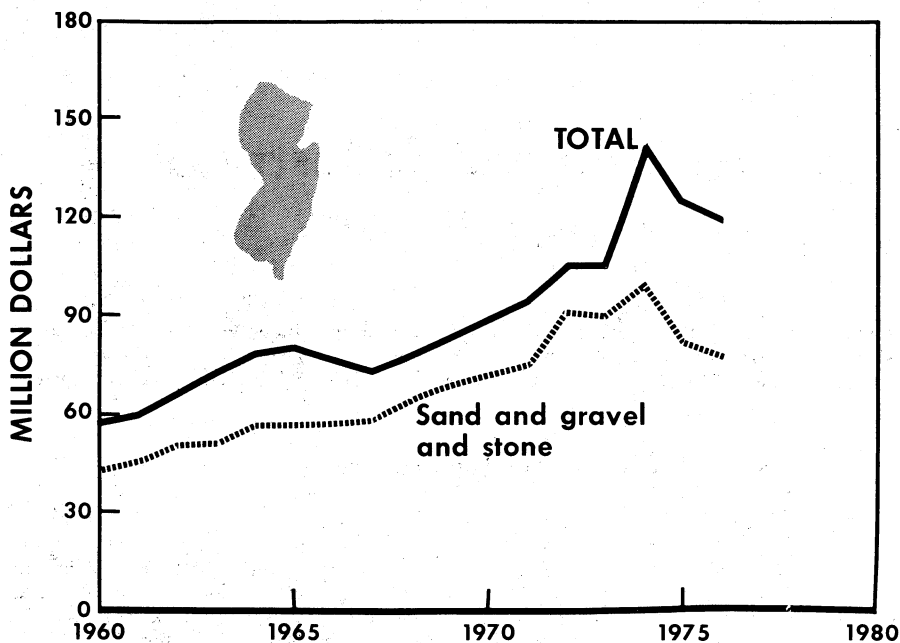


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in New Jersey.

Table 2.—Value of mineral production in New Jersey, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Atlantic	W	W	Sand and gravel.
Bergen	W	W	Do.
Burlington	\$5,944	\$4,593	Do.
Camden	1,876	1,546	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	W	Stone.
Hunterdon	4,337	W	Do.
Mercer	W	W	Do.
Middlesex	W	W	Sand and gravel, clays.
Monmouth	842	574	Sand and gravel.
Morris	8,066	W	Sand and gravel, stone.
Ocean	W	W	Ilmenite, sand and gravel.
Passaic	6,680	6,972	Stone, sand and gravel.
Somerset	19,582	W	Stone, clays.
Sussex	W	W	Zinc, stone, sand and gravel, peat, manganese residuum, lime.
Union	W	W	Stone.
Warren	W	W	Sand and gravel, peat, stone.
Undistributed ²	76,374	106,198	
Total ³	123,702	119,886	

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

¹ Salem County is not listed because no 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

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	3,242.0	3,307.0	+2.0
Unemployment -----do-----	332.0	345.0	+3.9
Employment (nonagricultural):			
Mining -----do-----	2.8	2.7	-3.6
Manufacturing -----do-----	747.4	753.3	+0.8
Contract construction -----do-----	99.2	94.6	-4.6
Transportation and public utilities -----do-----	174.3	175.9	+0.9
Wholesale and retail trade -----do-----	599.3	618.3	+3.2
Finance, insurance, real estate -----do-----	135.2	138.2	+2.2
Services -----do-----	472.1	490.1	+3.8
Government -----do-----	470.0	470.4	+0.1
Total nonagricultural employment -----do-----	¹ 2,700.2	¹ 2,743.4	+1.6
Personal income:			
Total -----millions--	\$49,591	\$54,152	+9.2
Per capita -----do-----	\$6,763	\$7,381	+9.1
Construction activity:			
Number of private and public residential units authorized--			
Value of nonresidential construction -----millions--	23,440	30,750	+31.2
Value of State road contract awards -----do-----	\$850.1	\$467.5	+23.0
Shipments of portland and masonry cement to and within the State -----thousand short tons--	\$69.6	\$250.0	+259.2
Mineral production value:	1,494	1,420	-4.9
Total crude mineral value -----millions--	\$123.7	\$119.9	-3.1
Value per capita, resident population -----do-----	\$17	\$16	-5.9
Value per square mile -----do-----	\$15,786	\$15,299	-3.1

^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.

certain conditions, and amending or repealing certain sections of the DEP Act of 1970.

A State law, effective January 1, 1976, imposed strict soil-erosion and sediment control standards at virtually every development site in the State. In late August, an oil spill liability bill was passed that allows the resort industry to recoup losses caused by oil spills offshore in the Atlantic Ocean.

DEP also considered nondegradation standards for ground water and surface water in the Pine Barrens of the State. Other proposed standards pertain to the transportation of radio-active materials.

DEP also issued a summary interim standard on sulfur in fuel that allows higher sulfur fuels to be used providing certain monitoring procedures are adopted.

In early February, the Governor ordered DEP to relax New Jersey's restrictions on sulfur emissions in the atmosphere in an effort to boost the economy of south New Jersey. The program allows use of higher sulfur fuels coupled with a system to monitor the sulfur dioxide content of the air for a 6-month period after which the State and the Federal Governments will determine whether the industries may continue

to burn the less costly, but higher sulfur content fuels. Cumberland is the last of four south New Jersey counties to install the monitors, which are already in operation in Cape May, Atlantic, and Salem Counties.

The Environmental Protection Agency (EPA) announced in late 1975 that the experimental fluidized bed combustion plant at Linden, N.J., was continuously and successfully operated for over 100 hours, indicating the possible use of this technology for coal-fired electric powerplants.

Nuclear Energy.—The Public Service Electric and Gas Co. (PSE&G) signed a contract with Kerr McGee Corp. for delivery of 20 million pounds of uranium between 1980-85. PSE&G's 1.6-million electricity customers throughout the State began receiving power from the 1,090-megawatt (MW) Salem No. 1 nuclear plant located on Artificial Island which began operation in December, but only at 10% of capacity, to determine the effectiveness of safety protective systems. The second 1,110-MW Salem No. 2 unit was scheduled to begin commercial operations in 1979. In 1975, 15% of the electricity sold by PSE&G was nuclear and approxi-

mately 26% in 1976 with anticipated nuclear growth in the future. PSE&G's other nuclear plants under construction are located adjacent to the Salem complex. The Hope Creek nuclear generating station consisting of two units, each with a capacity of 1,100 MW, reportedly will be in service in 1979, and the second unit will be in service in 1984. PSE&G also is proceeding with plans for the world's first offshore floating nuclear station located 12 miles northeast of Atlantic City and 2.8 miles off Little Egg Harbor. Each of the two nuclear units will be rated at 1,150 MW with construction scheduled to begin in 1985 and 1987. Offshore Power Systems, a subsidiary of Westinghouse Electric Corp., will produce the floating nuclear plants.

Other nuclear stations planned are Jersey Central Power and Light Co.'s Forked River plant located in Ocean County. At present, Jersey Central operates the Oyster Creek nuclear station in Ocean County which is rated at 646 MW.

Pending a report on safety hazards near nuclear plants, the Commissioner of DEP declared a moratorium on the issuance of CAFRA permits "for the construction of residential developments or other heavily occupied facilities, any part of which falls within 4 miles of the Oyster Creek facility or 6.6 miles of the Salem facility." DEP's land use controls are being formulated for many of the New Jersey areas.

In early October, Atlantic City Electric, which has a 5% interest in the Hope Creek nuclear plant, announced the closing of the two 35-year-old coal burning units located in Atlantic City. The obsolete units have been out-of-service for about 2 years, after the variances that allowed the company to burn coal had expired.

New Jersey, one of four east coast States, petitioned the Federal Power Commission to establish standards for selection of sites for liquified natural gas terminals near Staten Island and in the lower Delaware River to minimize the perils of fire and explosions in heavily populated or industrialized areas.²

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement into New Jersey totaled 1,366,000 tons, 5% less than in 1975. Masonry shipments into New Jersey were 53,800 tons, 6% more than in 1975. Most of the portland and masonry cement was manufactured in eastern Pennsylvania and eastern New York. Cement was distributed from five terminals, two in Jersey City, and one each in Bayonne, Elizabethport, and Newark.

Clays.—The quantity of clay produced decreased 9% from 67,319 tons in 1975 to 61,549 tons in 1976. Total value was 11% lower and the average unit value of clay decreased \$0.15 per short ton from \$5.52 in 1975 to \$5.37 in 1976. Common clay and shale accounted for 81% of the total tonnage and 76% of the value, while fire clay accounted for the remaining 19% of tonnage and 24% of value. Common clay and shale were used for face brick, and fire clay was used for foundry sand, fire brick, refractory mortar and cement, and caulking putty. Common clay and shale were produced in Somerset County, and fire clay in Cumberland and Middlesex Counties. The leading clay producer was New Jersey Shale Brick & Tile Corp.,

and the leading fire clay producer was J. S. Morie & Son, Inc.

Gem Stones.—Collectors and dealers collected mineral specimens from several localities, refuse areas, and abandoned quarries located principally in the northern part of the State. The value of the material collected was estimated to be \$17,000, 6% more than in 1975.

Graphite (Synthetic).—The Celanese Research Laboratory, Celanese Corp., Summit plant, located in Union County was the only producer of synthetic graphite within the State. Compared with 1975, value decreased 57%. Principal uses for the synthetic graphite were for carbon raisers and for machine and rough shapes.

Gypsum.—National Gypsum Co., The Flintkote Co., and Celotex Corp. calcined gypsum in Burlington, Bergen, and Camden Counties. Output was used mainly in the manufacture of wallboard, lath, and sheathing. Production decreased 7.6%, but increased 20.2% in value compared with 1975.

Iodine.—Nine companies in eight counties consumed 633,022 pounds of crude

² Constructioner. May 24, 1976.

iodine, a 22.7% increase compared with 1975. Iodine was consumed in the manufacture of resublimed iodine, potassium iodide, sodium iodide, and organic iodide containing compounds. Iodine was also used as catalysts, food supplements, stabilizers, in inks and colorants, pharmaceuticals, and sanitary uses.

Lime.—Consumption of lime in New Jersey increased 8.2% from 113,313 tons in 1975 to 122,589 tons in 1976. Practically all of this lime came from other States. Only one company located in Sussex County reported production of lime during 1976.

Magnesium Compounds.—Production of magnesium compounds decreased 6.8% in quantity and 22.6% in value compared with 1975. Nationally, New Jersey produced 7.1% of the total quantity compared with 8.2% in 1975. Refractory magnesia was produced in Cape May County by Harbison-Walker Refractories.

Marl, Greensand.—Output of greensand marl increased 26.4% in quantity, and nearly 11% in value compared with 1975. The marl was produced in Gloucester County and used for water treatment and agricultural purposes.

Peat.—Production of peat decreased 8% in quantity, from 28,700 tons in 1975 to 26,300 in 1976. Total value also decreased 17%, but average unit value increased \$2.77 per ton to \$26.08 in 1976. Peat was recovered from bogs near Newton and Stanhope in Warren County. Leading producers were Hyper-Humus Co., Mt. Bethel Humus Co., Inc., Netcong Natural Products, and Kelsey Humus & Partac Peat Co. Most of the output was used for general soil improvement with minor use for packing flowers and as an ingredient for potting soil.

Perlite.—Crude perlite was expanded at two plants in Middlesex County. Production decreased 5.6%, but value increased 13.4% compared with 1975. Expanded

perlite was used in roof insulation, in plaster and concrete aggregate, in masonry and cavity filler, and as a soil conditioner.

Sand and Gravel.—The total output of sand and gravel declined 4.5% in quantity and 0.5% in value compared with 1975. Construction sand and gravel accounted for 77% of the quantity and 51% of the value; industrial sand and gravel accounted for 23% of the quantity and 49% of the value. Of the 9,601,000 tons of construction sand and gravel sold or used, 31% was used for concrete aggregate, 35% for concrete products, 13% for asphaltic concrete aggregates and other bituminous mixtures, and the remaining 21% for roadbase and coverings, fill, and other uses. The average value per ton of construction sand and gravel was \$2.12 per short ton and \$6.79 per short ton for industrial sand and gravel. During the year, 68 mines produced sand and gravel in 14 counties compared with 73 mines in 1975.

The leading county was Cumberland with 11 mines producing 22.3% of the sand and gravel and 45.8% of the total value.

The largest producers of construction and industrial sand and gravel were Warner Co., Pennsylvania Glass Sand Corp., Houdaille Construction Materials, Inc., Saxon Falls Sand & Gravel Co., and New Jersey Pulverizing Co.

Thirteen of the 53 operations producing construction sand and gravel, 2 of the 13 operations producing industrial sand and gravel, and 1 of the 2 operations producing both construction and industrial sand and gravel produced less than 25,000 short tons per year per operation, or 16 of the 68 small operations produced 1% of the total tonnage.

Of the sand and gravel shipped to market, 76% was by truck, 14% by rail, 8% by water, 1% by other means, and 1% was used at the pit site.

Table 4.—New Jersey: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value
Construction:				
Processed:				
Sand -----	5,901	11,840	6,577	12,185
Gravel -----	2,847	7,786	3,023	8,123
Unprocessed:				
Sand and gravel -----	1,535	1,345	(²)	(²)
Industrial:				
Sand -----	2,730	16,321	2,819	19,131
Gravel -----	W	W	W	W
Total ³ -----	13,012	37,293	12,420	39,439

W Withheld to avoid disclosing individual company confidential data; included with "Industrial sand."

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant for blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

² Included with processed sand and gravel.

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

Table 5.—New Jersey: Construction aggregate (blended sand and gravel) sold or used commercially by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highway, bridges, dams, waterworks, airports, etc.) --	3,258	8,129	2,959	7,271
Concrete products (cement blocks, bricks, pipe, etc.) --	3,228	8,153	3,384	7,154
Asphaltic concrete aggregates and other bituminous mixtures -----	968	2,546	1,265	2,657
Roadbase and coverings -----	363	694	719	1,141
Fill -----	1,354	1,487	959	1,002
Other -----	103	263	312	1,033
Total ¹ -----	9,273	21,273	9,601	20,309

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

Table 6.—New Jersey: Sand and gravel sold or used by county, in 1976

(Thousand short tons and thousand dollars)

County	Number		Quantity	Value
	Mines	Companies		
Atlantic -----	2	2	W	W
Bergen -----	1	1	W	W
Burlington -----	3	3	2,020	4,593
Camden -----	6	4	603	1,546
Cape May -----	3	3	582	1,056
Cumberland -----	11	8	2,765	18,076
Gloucester -----	6	5	84	133
Middlesex -----	4	4	644	1,430
Monmouth -----	3	3	244	674
Morris -----	6	5	1,850	4,033
Ocean -----	7	7	1,820	2,673
Passaic -----	6	6	503	1,883
Sussex -----	8	8	506	933
Warren -----	2	2	W	W
Total -----	68	61	12,420	39,439

W Withheld to avoid disclosing individual company confidential data; included in "Total."

Stone.—Crushed and broken stone production decreased 5% in quantity from 11.8 million to 11.2 million short tons and 8% in value from \$42.4 million to \$39 million compared with 1975. Traprock, crushed and broken granite, limestone, sandstone, and dimension stone, in decreasing order of tonnage, were the primary types of stone quarried in 1976. Traprock continued as the leading type of stone produced and accounted for 73% and 70% of the State's total crushed and broken stone production and value. Among the States, New Jersey ranked second in output of crushed traprock producing 8.3 million tons. Average value per short ton for traprock was \$3.30 compared with \$3.49 for the average value per short ton of all stone produced in the State.

Crushed and broken granite decreased 15% in quantity and 17% in value compared with 1975. The unit value of \$2.72 per short ton was \$0.09 cents less than in 1975. The principal uses of granite were dense-graded roadbase, bituminous aggregate, and concrete aggregate.

Crushed stone used for roadstone, roadbase aggregate, bituminous aggregate, and other uses were produced at 31 quarries while 2 quarries produced dimension stone. Of the 33 quarries operating in 10 counties, 2 were located in Essex County, 1 in Hudson, 6 in Hunterdon, 1 in Mercer, 2 in Morris, 6 in Passaic, 8 in Somerset, 5 in Sussex, and 1 each in Union and Warren Counties.

Somerset County was the leading producer of all types of stone with 41% of the State's total followed by Passaic, 15%; Sussex, 11%; Morris, 10%; and Hunterdon, 9%;

Ten of the 33 quarries produced less than 100,000 short tons per quarry while only 2 quarries produced over 900,000 short tons each. Ninety-four percent of the crushed and broken stone was shipped to market by truck with the remaining 6% being shipped by rail.

The leading producers of stone in descending order were Trap Rock Industries Inc., Houdaille Inc., Mt. Hope Materials Corp., Union Building Materials Construction Corp., and Penn-Va. Corp.

Table 7.—New Jersey: Crushed and broken stone¹ sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	1,899	8,004	1,810	5,659
Concrete aggregate -----	593	1,623	369	1,068
Dense-graded roadbase stone -----	3,796	11,940	2,455	8,048
Macadam aggregate -----	W	W	355	1,269
Roadstone -----	4,025	13,920	4,809	16,010
Riprap and jetty stone -----	112	390	112	396
Surface treatment aggregate -----	247	693	107	341
Other uses ² -----	1,148	5,811	1,215	6,219
Total ³ -----	11,821	42,381	11,234	39,012

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

¹ Includes traprock, granite, limestone, and sandstone.

² Includes roofing granules, railroad ballast, agricultural limestone, other filler, asphalt filler (1976), fill (1976), filter stone, flux stone, acid neutralization, mineral food (1976), other uses, and uses indicated by symbol W.

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

Sulfur.—Recovered sulfur increased 30.9% from 82,747 long tons in 1975 to 108,332 long tons in 1976. The total value of all sulfur produced in the State increased 36% from \$3,709,324 in 1975 to \$5,042,934 in 1976. The unit value per long ton increased \$1.72 from \$44.83 in 1975 to \$46.55 in 1976. Elemental sulfur was recovered as a byproduct of petroleum refining at four plants, two located in Gloucester County and one each in Middlesex and Union Counties.

Vermiculite.—Exfoliated vermiculite was produced at one plant each in Mercer and Middlesex Counties from crude vermiculite mined in other States. Exfoliated vermiculite sold or used increased 20%, in quantity and 9% in value, but decreased 9% in average unit value compared with 1975. Exfoliated vermiculite was used mainly for agricultural purposes, loose fill insulation, fire proofing, and lightweight concrete aggregate.

METALS

Copper.—ASARCO, Inc., announced in late January the closing of its copper refinery located in Perth Amboy. The plant had been operating at 60% capacity because of a weak demand for copper. The plant was acquired by ASARCO in 1901.³

AMAX Inc. announced in late January a temporary reduction in copper production at its Carteret refinery owing to a shortage of scrap material.⁴

Ferroalloys.—Shieldalloy Corp., Newfield, Gloucester County, produced ferroalloys of vanadium, titanium, boron, columbium, and columbium-nickel.

United States Steel Corp.'s American Bridge Div., located in Trenton, was closed in late April because of a depressed construction market, an aging plant, and economic conditions. The plant was founded in 1845 by Peter Cooper as the South Trenton Iron Co. with acquisition by United States Steel in 1901. The shutdown does not affect United States Steel's wire products plant which is a division of United States Steel's Fairless works.

Iron Ore.—The Mt. Hope Mining Co., Morris County, scheduled the reopening of the magnetite mine located near Mt. Hope in early 1977. Annual production of 400,000 to 500,000 tons of magnetite ore is planned with reserves adequate for 20 years. This mine was first opened in 1640 with regular production beginning in 1710. In 1959 the property was closed because of competition with imported iron ores.

Pigments.—Metal-base pigments used primarily in the manufacture of paint were produced at five plants in four counties. Production increased in 1976 over that of 1975. Value of all produced iron oxide pigments also increased in 1976. Iron oxide pigments were produced in Camden County by Combustion Engineering; in Essex County, by E.I. duPont de Nemours & Co., Inc., and by Sterling Drug, Inc.; and in Mercer and Middlesex Counties, by Cities Service Co.

Selenium.—Primary selenium was produced by ASARCO, Inc. Cataret, and by The Anaconda Co., Perth Amboy. Production increased 30.7% compared with 1975. Selenium, a byproduct of the electrolytic copper process, is used mainly for electronic components, ceramics and glass, chemicals, and for other minor uses. Selenium is also used in rectifiers, photo-

electric cells, and other electronic components. Small portions of selenium, when added to glass melts, neutralize the green coloration caused by iron while larger amounts produce gray and bronze-tinted window glass that reduces glare and heat transmission.

Tellurium.—Tellurium was produced by AMAX Inc., Cataret, and The Anaconda Co., Perth Amboy, with an increase of 10% compared with 1975. The major uses of tellurium were for mold dressing and cast iron products, for improvement of machinability of some low-carbon steels and high-strength alloy steels, and for use in various chemicals. Tellurium is commercially recovered principally from the precious metal rich anode slimes obtained from the electrolytic refining of copper.

Titanium.—In 1976, production of ilmenite concentrate increased 20% in quantity and 9% in value compared with 1975. Glidden Durkee Div. of SCM Corp. recovered ilmenite from a sand deposit near Lakehurst, Manchester, and Jackson Townships, Ocean County. The total potentially economic reserves in this area are estimated to be in an area of more than 15,000 acres, although residential development will probably affect production of the sands which have a mineral concentration of 3% for depths to 25 feet, and occasionally the concentration may be found to depths of 80 feet or more. Smaller areas of ilmenite ore with a mineral concentration less than the Lakehurst area are located near Browns Mills and Medford Lakes, Burlington County. ASARCO, Inc., began shipping ilmenite from its new suction dredging system near Lakehurst. The dredged sand is upgraded to a 63% titanium dioxide concentrate in two successive stages. A third unnamed company completed preliminary drilling tests to determine feasibility of ilmenite production in the Lakehurst area. Ilmenite, an ore containing titanium dioxide, is used in the manufacture of paints, paper, rubber, and leather products.

Zinc.—New Jersey ranked sixth nationally in the production of zinc, behind Missouri, Tennessee, New York, Colorado, and Idaho, producing 33,767 tons or 67.5 million pounds valued at \$24,987,000, an 8.6% increase in production and 3% increase in

³ Mining Congress Journal. V. 62, No. 2. February 1976, p. 9.

⁴ Wall Street Journal. Jan. 22, 1976.

value compared with 1975. Unit prices of zinc in 1976 were \$0.3700 per pound or \$740.00 per ton. Zinc was produced only in Sussex County, and the ore was crushed and shipped directly to a company-owned smelter at Palmerton, Pa., where zinc and manganiferous residue were recovered. Zinc is used primarily for galvanizing, brass products, and zinc-base alloys.

MINERAL FUELS

Hydrocarbon Research Inc. (HRI) was awarded a \$4 million, 34-month contract by the Energy Research and Development Administration (ERDA) to test a new technique for converting coal to low British thermal unit (Btu) gas. The new process will use 9 tons of coal per day, and tests will be conducted at the HRI facilities located at Trenton.

Natural Gas.—PSE&G announced in early June processing of applications for new gas service. This decision followed a ruling June 1 by the State Public Utilities Commission (PUC) which lifted a moratorium on new gas service connections imposed in 1973 because of a natural gas shortage. In June PUC permitted PSE&G and Elizabethtown Gas Co. to add new gas customers, but on a limited basis.

South Jersey Gas Co., serving 121,000 customers in south New Jersey, anticipated additional gas supplies and requested permission from PUC to add new customers, but were refused because of uncertainties of reliable gas supply deliveries from Transcontinental Pipeline Co. which is the only supplier for South Jersey Gas Co.

PSE&G and the Boston-based Algonquin Gas Transmission Co. signed a contract to purchase natural gas for 22 years from SONATRACH, the Algerian national oil and gas agency. Approximately 219,000 billion cubic feet of natural gas would be purchased from SONATRACH annually, but at higher prices than normally paid to interstate gas transportation suppliers.

The Intercontinental Pipeline Co. of Vineland was formed in 1971 specifically for construction of a deepwater port in the Delaware Bay and its necessary onshore facilities including pipelines to oil refineries in the Philadelphia and New York areas.

In late July the New Jersey DEP approved controversial plans for oil and chemical storage tanks along pier facilities in the Hudson River. The tank farm would be built at Jersey City and Bayonne,

several miles from Liberty State Park and the southern tip of Manhattan.

El Paso Natural Gas Co. cancelled plans for construction of a liquefied natural gas (LNG) terminal in Logan Township, Gloucester County, but is continuing with plans for the LNG facility at West Deptford, also in Gloucester County.

At yearend the U.S. Office of Technology Assessment reported that it would be at least 10 years before the first deepwater port is built to serve the mid-Atlantic region.

In early July PUC granted the New Jersey Gas Co. its first rate increase in 23 years, a \$2.7 million increase affecting 223,000 customers. In early May PUC ordered PSE&G to refund \$6.19 million to its customers plus a 10% interest penalty for overpayments for the first 3 months of the year of the utilities raw materials adjustment charge. In late August PUC ordered PSE&G to refund \$17.1 million to its gas customers for overcharges made during the first 9 months of the year.

On October 14, PUC granted an overall 7.7% or \$136.5 million rate increase for electric and gas users served by PSE&G. The rate increase becomes effective on October 21 for the 1.9 million customers throughout the State.

For natural gas consumers in New Jersey, the fuel adjustment clause increases were 27.8% of total revenues collected by the utilities in 1975. New Jersey is one of eight States where explicit utility commission approval is required before fuel adjustment clauses can go into effect.

Petroleum.—The Coastal Zone Management Act of 1972 and the amendments of 1975 authorized and assisted the coastal States to study, plan for, manage, and control the impact of energy resource development and production which affects the coastal zone. The amendments require coastal areas to carefully plan for energy facilities that have to be on the coast so they do not damage these valuable areas and the amendments also compensate those areas affected. With the possibility of large quantities of oil and gas in the Baltimore Canyon located off the New Jersey Coast, the coastal States prepared to safeguard coastal areas from effects of offshore drilling. Results of the first deep stratigraphic test well drilled on the Atlantic Outer Continental Shelf (OCS) indicate a potential for oil and gas in the Baltimore

Canyon trough area, according to a U.S. Geological Survey, Department of the Interior report. The report summarizes geological, geophysical, and engineering data obtained from the drilling of a 16,043-foot well off the New Jersey coast prior to OCS sale No. 40 held on August 17, 1976. The well, designated Continental Offshore Stratigraphic Test (COST) No. B-2, located 91 miles east of Atlantic City, was drilled in 298 feet of water. Drilling of the well began in December 1975 and it was completed in March 1976. The report published as U.S. Geological Survey Open File report No. 76-774 was available November 8, 1977, for public inspection at U.S. Geological Survey libraries located in Menlo Park, Calif.; Golden, Colo.; Reston, Va.; and at U.S. Geological Survey Public Inquiries offices located in Los Angeles, Calif.; Anchorage, Alaska.; Dallas, Tex.; and the U.S. Geological Survey offices in Washington, D.C., and Metairie, La.⁵

The largest bid of \$107.8 million was for Tract 29 by a group headed by Mobil Oil Corp. Other members of the group were Amerada Hess Corp., Anadarko Production Co. and Pan Canadian Petroleum Co. Exxon Corp. offered \$730 million on 69 of the tracts, apparently winning 34 tracts with high bids totaling \$348.6 million. Oilmen estimated that it would be 6 months before oil and gas drilling begins in the Atlantic Ocean off the New Jersey coast.⁶

During the year there were four petroleum refineries in New Jersey, one each in Perth Amboy, Linden, Paulsboro, and Westville. All of the crude oil processed came from outside the State.

Oil spills remained a problem throughout the year. The Ethel H, a barge being towed to the Hess Oil facility, struck bottom rupturing a tank and spilling 400 gallons of heavy No. 6 oil into the Arthur Kill, a narrow waterway separating New Jersey and Staten Island.

In late December the Liberian tanker Olympic Games ran aground in the Delaware River, gouging a hole in the hull and spilling 133,000 gallons of oil.

Large oil spills are being tracked by buoys dropped into the oil spill which sends radio signals to a National Aeronautics and Space Administration (NASA) satellite while smaller spills are cleaned up to prevent effects on shore. Effects of petroleum products on aquatic animals are being studied on the Rann Dom Sampler, a 42-foot floating laboratory cruising the Delaware River between Trenton and the Delaware Bay. The Governor urged prompt legislative action on an oil spill bill to protect the resort industry from losses resulting from oil spills in the Atlantic Ocean.

⁵ Department of the Interior News Release. Aug. 25, 1976.

⁶ Wall Street Journal. Aug. 19, 1976.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Fire:			
Almasi Clay Co -----	Metuchen Ave. Woodbridge, N.J. 07095	Plant -----	Middlesex.
J. S. Morie & Son, Inc. -----	Box 35 Mauricetown, N.J. 08329	Pit -----	Cumberland.
Miscellaneous:			
New Jersey Shale Brick & Tile Corp. -----	Box 490 Somerville, N.J. 08876	Plant -----	Somerset.
Gypsum, calcined:			
The Flintkote Co -----	480 Central Ave. East Rutherford, N.J. 07073	----do -----	Camden.
Jim Walter Corp -----	No. 1 River Rd. Edgewater, N.J. 07020	----do -----	Bergen.
National Gypsum Co -----	325 Delaware Ave. Buffalo, N.Y. 14202	----do -----	Burlington.
Ilmenite:			
ASARCO, Inc -----	Route 70, Mile 41 Lakehurst, N.J. 08733	----do -----	Ocean.
Glidden-Durkee Div. of SCM Corp. -----	Box 5 Lakehurst, N.J. 08733	----do -----	Do.
Iron oxide pigments (manufactured):			
Cities Service Co -----	380 Madison Ave. New York, N.Y. 10017	----do -----	Mercer and Middlesex.
Combustion Engineering, C.E. Minerals Div. -----	901 E. 8th Ave. King of Prussia, Pa. 19406	----do -----	Camden.
E. I. du Pont de Nemours & Co., Inc. -----	Du Pont Bldg., D 10034 Wilmington, Del. 19898	----do -----	Essex.
Magnesium compounds:			
Harbison-Walker Refractor- ies, a division of Dresser Industries. -----	2 Gateway Center Pittsburgh, Pa. 15222	----do -----	Cape May.
Marl, greensand: Inversand Co. -----	226 Atlantic Ave. Clayton, N.J. 08312	Pit -----	Gloucester.
Peat:			
Hyper-Humus Co -----	Lafayette Rd. Box 267 Newton, N.J. 07860	Bog -----	Sussex.
Kelsey Humus & Partac Co. -----	Kelsey Park Great Meadows, N.J. 07838	Bog -----	Warren.
Mt. Bethel Humus Co., Inc. -----	315 W. 57th St. New York, N.Y. 10019	Bog -----	Sussex.
Netcong Natural Products -----	738 Rt. 10 Randolph, N.J. 07801	Bog -----	Do.
Perlite (expanded):			
Grefco, Inc -----	3450 Wilshire Blvd. Los Angeles, Calif. 90010	Plant -----	Middlesex.
The Schundler Co -----	Box 251 Metuchen, N.J. 08840	----do -----	Do.
Sand and gravel:			
Brick-Wall Corp -----	Route 70 Lakehurst, N.J. 08733	Pit -----	Ocean.
Houdaille Construction Materials, Inc. -----	10 Park Pl. Morristown, N.J. 07960	Pits -----	Morris, Ocean, Warren.
J. S. Morie & Son, Inc -----	Box 35 Mauricetown, N.J. 08329	2 pits and 2 dredges.	Cumberland.
New Jersey Pulverizing Co. -----	115 Hickory Lane Bayville, N.J. 08721	Pit -----	Ocean.
New Jersey Silica Sand Co. -----	Millville, N.J. 08332	Pit -----	Cumberland.
Pennsylvania Glass Sand Corp. -----	Berkley Springs, W.Va. 25411	Pit -----	Do.
Saxon Falls Sand & Gravel Co., Inc. -----	R.D. 3 Stanhope, N.J. 07874	Pit -----	Morris.
Tuckahoe Sand & Gravel -----	Box 101 Tuckahoe, N.J. 08250	Pit -----	Cape May.
Warner Co -----	1721 Arch St. Philadelphia, Pa. 19103	Dredge -----	Burlington.
Whitehead Brothers Co -----	60 Hanover Rd. Florham Park, N.J. 07932	Pit and dredge -----	Cumberland.
Stone:			
Granite, crushed and broken:			
Anthony Ferrante & Sons, Inc. -----	Route 202, Mine Brook Rd. Bernardsville, N.J. 07924	Quarry -----	Hunterdon and Somerset.
Hamburg Quarry, Inc -----	Route 23 Hamburg, N.J. 07419	----do -----	Sussex.
Passaic Crushed Stone Co., Inc. -----	Box 348 Pompton Lakes, N.J. 07442	----do -----	Passaic.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Traprock (basalt), crushed and broken:			
Tri County Asphalt Corp.	Route 15 Hopatcong, N.J. 07843	Quarry -----	Sussex.
Fanwood Crushed Stone Co.	141 Central Ave. Westfield, N.J. 07090	----do -----	Somerset.
Anthony Ferrante & Sons, Inc.	Route 202, Mine Brook Rd. Bernardsville, N.J. 07924	----do -----	Do.
Houdaille Construction Materials, Inc.	10 Park Pl. Morristown, N.J. 07960	----do -----	Hunterdon, Passaic, Somerset, Union.
M. L. Kernan Quarry	500 Tilton Rd. South Orange, N.J. 07979	----do -----	Essex.
Mt. Hope Materials Corp.	R.D. No. 1 Wharton, N.J. 07885	----do -----	Morris.
Orange Quarry Co	318 Eagle Rock Ave. West Orange, N.J. 07050	----do -----	Essex.
Penn-Va. Corp	Box 490 Newton, N.J. 07860	----do -----	Sussex.
Trap Rock Industries, Inc.	Laurel Ave. Kingston, N.J. 08528	----do -----	Hunterdon, Mercer, Somerset.
The Union Building & Construction Corp.	111 Clifton Ave. Clifton, N.J. 07013	----do -----	Passaic.
Sulfur (recovered):			
Chevron Oil Co	1200 State St. Perth Amboy, N.J. 08861	Plant -----	Middlesex.
Exxon Co. U.S.A	Box 23 Linden, N.J. 07036	----do -----	Union.
Mobil Oil Corp	Paulsboro, N.J. 08066	----do -----	Gloucester.
Texaco Inc	Eagle Point, Box 52332 Houston, Tex. 77052	----do -----	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, Mass. 02140	----do -----	Mercer.
The Schundler Co	Box 251 Metuchen, N.J. 08840	----do -----	Middlesex.

The Mineral Industry of New Mexico

By Herman W. Sheffer¹

Mineral production in New Mexico continued to rise to another record high in 1976, reaching a total value of more than \$2.5 billion, an increase of 22% over that of 1975. However, unlike 1975 when the high increase in the value of minerals produced was a reflection of increased prices since the quantity of production decreased, substantial increases in both quantity and value were realized by 20 commodities produced in the State. In 1976, New Mexico ranked eighth in the Nation in mineral production value. New Mexico continued to produce a broad variety of minerals including fuels, metals, and nonmetals, and the industry comprised a major sector of the State's economy. New Mexico continued to be the leading producer of perlite, potassium salts, and uranium in the United States. The State was also among the leaders in output of copper, molybdenum, natural gas, natural gas liquids, pumice, and crude petroleum. Fuels continued to rank first in value of production totaling more than \$1.8 billion, followed by metals totaling nearly \$0.5 billion, and nonmetals totaling more than \$0.2 billion. Of the 31 minerals reported produced in New Mexico, 6 accounted for more than 93% of the total mineral production value. These minerals ranked by value, with percentage showing individual share of the total were as follows: Petroleum (32.4%), natural gas (27.7%), copper (9.6%), natural gas liquids (9.2%), uranium (7.6%), and potassium salts (6.6%).

Mining operations were located throughout the State; however, most of the petroleum and natural gas was produced in the

southeastern and northwestern parts. Copper was produced principally in the southwestern corner of the State; uranium was mined and processed in the west-central part of the State; potash was mined and processed in the southeastern part; and most of the molybdenum and perlite was produced in the north-central part of New Mexico. Coal was mined and used to generate electricity in the northwestern part of the State; additional coal for use in steelmaking was mined in the northeastern part of the State.

New Mexico was a significant supplier of raw materials to other States since most of the mineral industry's products were consumed outside the State.

Principal events in the mining industry of New Mexico during 1976 included the following: Start of production in July at the \$268 million Phelps-Dodge Corp. copper smelter in Hidalgo County; continued exploration by Molybdenum Corp. of America (Molycorp) and Kennecott Copper Corp. to determine the possibility of further development of Molycorp's Questa molybdenum property; continuation by New Mexico as leader in the United States in uranium production; continued exploration for and development of new uranium properties and startup of new mines in the Grants Uranium Belt; start of production at a new perlite mine and plant near Socorro by Grefco, Inc.; and notable increases in the production of clays, coal, copper, natural gas, perlite, pumice, sand and gravel, silver, and uranium.

¹ State Liaison Officer, Bureau of Mines, Santa Fe, N. Mex.

Table 1.—Mineral production in New Mexico ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide (natural).....thousand cubic feet..	569,352	\$60	856,548	\$80
Clays ²thousand short tons..	44	61	56	116
Coal, bituminous.....do.....	8,785	W	9,760	W
Copper (recoverable content of ores, etc.) short tons..	146,263	187,802	172,360	239,925
Gem stones.....do.....	NA	200	NA	210
Gold (recoverable content of ores, etc.) troy ounces..	15,049	2,430	15,198	1,905
Lead (recoverable content of ores, etc.) short tons..	1,931	830	W	W
Manganiferous ore (5% to 35% Mn).....do.....	49,976	W	45,362	W
Natural gas.....million cubic feet..	1,217,430	493,059	1,230,976	695,501
Natural gas liquids:				
Natural gasoline and cycle products thousand 42-gallon barrels..	9,194	45,292	9,490	51,369
LP gases.....do.....	30,214	122,065	32,654	180,577
Perlite.....thousand short tons..	429	6,400	481	8,403
Petroleum (crude).....thousand 42-gallon barrels..	95,063	788,073	92,130	814,419
Potassium salts.....thousand short tons..	^r 1,749	^r 150,622	2,083	165,354
Pumice.....do.....	397	1,280	486	1,560
Salt.....do.....	147	1,048	W	W
Sand and gravel.....do.....	6,220	13,798	7,702	16,671
Silver (recoverable content of ores, etc.) thousand troy ounces..	792	3,501	892	3,880
Stone.....thousand short tons..	2,197	4,683	1,935	4,394
Uranium (recoverable content U ₃ O ₈) thousand pounds..	10,393	127,829	11,880	191,271
Zinc (recoverable content of ores, etc.) short tons..	11,015	8,592	W	W
Value of items that cannot be disclosed:				
Cement, clay (fire clay), fluorspar (1975), gypsum, helium (high purity), iron ore (1975), lime, mica (scrap), molybdenum, tin, vanadium, and values indicated by symbol W.....do.....	XX	104,614	XX	134,492
Total.....do.....	XX	^r 2,062,239	XX	2,510,127
Total 1967 constant dollars.....do.....	XX	827,623	XX	^p 902,391

^p Preliminary. ^r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in New Mexico, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value ²
Bernalillo -----	W	\$21,012	Cement, sand and gravel, stone, clays.
Catron -----	W	W	Sand and gravel, stone, tin, pumice, salt.
Chaves -----	\$17,468	20,387	Petroleum, natural gas, sand and gravel, stone.
Colfax -----	W	W	Coal, sand and gravel.
Curry -----	--	W	Sand and gravel.
De Baca -----	W	W	Do.
Dona Ana -----	W	1,306	Sand and gravel, pumice, stone, clays.
Eddy -----	† 461,672	539,694	Petroleum, potassium salts, natural gas, natural gas liquids, salt, sand and gravel.
Grant -----	205,539	259,705	Copper, zinc, silver, lime, gold, lead, molybdenum, manganese ore, stone, helium, sand and gravel.
Guadalupe -----	--	W	Stone, sand and gravel.
Harding -----	60	80	Carbon dioxide.
Hidalgo -----	717	591	Sand and gravel, stone, clays, silver, gold, copper.
Lea -----	† 785,061	903,403	Petroleum, natural gas, natural gas liquids, potassium salts, sand and gravel, stone.
Lincoln -----	W	133	Sand and gravel, stone.
Luna -----	W	W	Sand and gravel, clays, stone.
McKinley -----	138,527	190,047	Uranium, natural gas liquids, coal, petroleum, stone, vanadium, sand and gravel, molybdenum, natural gas.
Mora -----	53	W	Sand and gravel, natural gas.
Otero -----	W	474	Sand and gravel, stone.
Quay -----	--	W	Do.
Rio Arriba -----	87,921	113,187	Natural gas, petroleum, natural gas liquids, sand and gravel, pumice, stone.
Roosevelt -----	14,679	19,048	Petroleum, natural gas liquids, natural gas, stone.
Sandoval -----	3,677	5,043	Petroleum, natural gas, sand and gravel, gypsum, copper, pumice, stone, silver, gold.
San Juan -----	212,313	283,764	Natural gas, coal, petroleum, natural gas liquids, sand and gravel, pumice, clays.
San Miguel -----	304	96	Sand and gravel, stone.
Santa Fe -----	2,878	1,202	Sand and gravel, pumice, gold, copper, silver.
Sierra -----	25	W	Sand and gravel, gold, silver, copper.
Socorro -----	W	W	Perlite, sand and gravel, stone, lead, silver, gold.
Taos -----	33,724	41,254	Molybdenum, perlite, sand and gravel, mica, stone.
Torrance -----	W	204	Stone, sand and gravel.
Union -----	W	W	Pumice, sand and gravel, stone.
Valencia -----	44,699	79,154	Uranium, sand and gravel, perlite, gold, silver.
Undistributed ³ -----	52,923	30,344	
Total ⁴ -----	† 2,062,239	2,510,127	

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Los Alamos County is not listed because no production was reported.

³ The value of petroleum is based on an average price per barrel for the State.

⁴ Includes gem stones which cannot be assigned to specific counties and values indicated by symbol W.

⁵ Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Mexico business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands ..	431.1	466.0	+ 8.1
Unemployment ----- do ..	31.2	43.0	+ 37.8
Employment (nonagricultural):			
Mining ----- do ..	20.3	21.3	+ 4.9
Manufacturing ----- do ..	28.6	30.1	+ 5.2
Contract construction ----- do ..	25.2	25.0	- .8
Transportation and public utilities ----- do ..	23.0	23.3	+ 1.3
Wholesale and retail trade ----- do ..	83.6	91.0	+ 8.9
Finance, insurance, real estate ----- do ..	16.3	17.0	+ 4.3
Services ----- do ..	68.3	78.8	+ 8.1
Government ----- do ..	104.8	107.7	+ 2.8
Total nonagricultural employment ----- do ..	¹ 370.2	¹ 389.1	+ 5.1
Personal income:			
Total ----- millions ..	\$5,525	\$6,217	+ 12.5
Per capita ----- do ..	\$4,830	\$5,322	+ 10.2
Construction activity:			
Number of private and public residential units authorized ----- do ..	6,904	8,348	+ 20.9
Value of nonresidential construction ----- millions ..	\$123.3	\$116.2	- 5.8
Value of State road contract awards ----- do ..	\$46.3	\$65.0	+ 40.4
Shipments of portland and masonry cement to and within the State ----- thousand short tons ..	555	559	+ .7
Mineral production value:			
Total crude mineral value ----- millions ..	[†] \$2,062.2	\$2,510.1	+ 21.7
Value per capita, resident population ----- do ..	[†] \$1,803	\$2,149	+ 19.2
Value per square mile ----- do ..	[†] \$16,950	\$20,681	+ 21.7

^P Preliminary. [†] Revised.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.

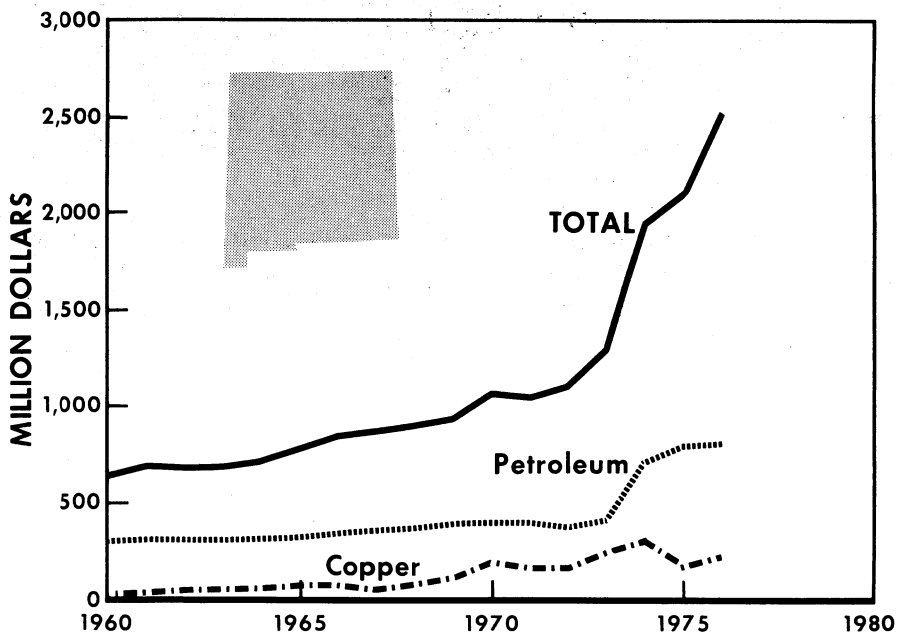


Figure 1.—Value of petroleum, copper, and total value of mineral production in New Mexico.

Legislation and Government Programs.—Environment and energy continued to be the focal points of government activities related to the mineral industry of New Mexico during 1976.

The Energy Resources Board, created by law in 1975, continued to develop energy strategies for the State. The newly created office of the State Geologist began studies aimed at determining reserves of known supplies of energy resources.

The New Mexico Coal Surfacemining Commission continued to administer the State mining reclamation law. Examinations of progress in reclamation at all coal strip mines were made three times during the year.

Papers relating to the mineral industry of New Mexico were published by the Federal Bureau of Mines,² the U.S. Geological Survey,³ and the New Mexico State Bureau of Mines and Mineral Resources (a division of the New Mexico Institute of Mining and Technology).⁴

Although the number of mining and oil and gas leases on Federal lands in New Mexico increased to 16,639 leases, total acreage amounted to 13,009,187, nearly 841,000 acres less than in 1975⁵ or nearly 49% of the federally owned acreage in the State and nearly 17% of the total area in the State. Mining leases on Federal land decreased from 653 in 1975 to 602 in 1976. Most of the mining leases were for potash and coal. Acreage of mining leases decreased nearly 20% from 912,065 acres to 734,586 acres in 1976. The number of oil and gas leases increased from 14,779 to 16,037; acreage of oil and gas leases decreased from 12,937,948 to 12,274,601.

Employment and Safety.—The New Mexico mining industry employed a total of 21,300 people, exclusive of clerical personnel, indicating that more than 6,000 people were employed in exploration, administration, and sales in addition to those listed in production categories. The 1976 Annual Report of the State Inspector of Mines listed employment in the mining industry, by category of activity, as follows:

Over 19,000 men and women were employed in the oil and gas industry in New Mexico during 1976, of which approximately 8,200 people were employed in the production of crude oil and natural gas; 900 were employed in the State's 8 petroleum refineries and more than 3,400 were employed in gas production and distribution.

During 1976 the metal, nonmetal, and coal mining industry experienced an accident frequency rate of 19.24 per million man-hours worked compared with 18.96 in 1975. The severity rate per million man-

² Cavallaro, J. A., M. T. Johnston, and A. W. Deurbrock. Sulfur Reduction Potential of the Coals of the United States. A Revision of Report of Investigation 7633. BuMines RI 8118, 1976, 323 pp.

Corsetino, J. S. Projects To Expand Fuel Sources in Western States. Survey of Planned or Proposed Coal, Oil Shale, Tar Sand, Uranium, and Geothermal Supply Expansion Projects, and Related Infrastructure, in States West of the Mississippi River. BuMines IC 8719, 1976, 208 pp.

Crump, L. H. Historical Fuels and Energy Consumption Data, 1960-72, United States by States and Census Districts West of the Mississippi. BuMines IC 8705, 1976, 425 pp.

Fuels and Energy Data: United States by States and Census Districts, 1973. BuMines IC 8722, 1976, 112 pp.

Merritt, R. C., H. D. Peterson, and C. N. Wentz. Heap Leaching Studies on Uranium Ores. BuMines OFR 118-76, 1976, 170 pp.

Moore, B. J. Analyses of Natural Gases, 1975. BuMines IC 8717, 1976, 82 pp.

³ Moore, H. J. Missile Impact Craters (White Sands Missile Range, N. Mex.) and Applications to Lunar Research. U.S. Geol. Survey Prof. Paper 812-B, 1976, pp. B1-B47.

⁴ Arnold, E. C., and others. New Mexico's Energy Resources '75. N. Mex. BuMines and Miner. Res. Bull. 107, 1976, 40 pp.

Lasky, S. G. The Ore Deposits of Socorro County, New Mexico. N. Mex. BuMines and Miner. Res. Bull. 8, 1932 (reprinted 1976), 139 pp.

Shoemaker, J. W., E. C. Beaumont, and F. E. Kottowski. Strippable Low-Sulfur Coal Resources of the San Juan Basin in New Mexico and Colorado. N. Mex. BuMines and Miner. Res. Memoir 25, 1971 (reprinted 1976), 189 pp.

Summers, W. K. Catalog of Thermal Waters in New Mexico. N. Mex. BuMines and Miner. Res. Hydrologic Rept. 4, 1976, 80 pp.

Verity, V. H., and R. J. Young. Laws Governing Mineral Rights in New Mexico. N. Mex. BuMines and Miner. Res. Bull. 104, 1973 (reprinted 1976), 70 pp.

⁵ U.S. Geological Survey. Federal and Indian Lands, Coal, Phosphate, Potash, Sodium, and other Mineral Production, Royalty Income & Related Statistics. Conservation Division Rept., June 1977.

	Coal	Metals	Non-metals	Sand and gravel	Other	Total
Surface -----	770	2,678	589	540	--	4,577
Underground -----	281	2,827	1,580	--	--	4,688
Mill or plant -----	--	877	210	408	3,514	5,009
Other -----	--	321	199	62	261	843
Total -----	1,051	6,703	2,578	1,010	3,775	15,117

hours worked for the same periods was 2,135 and 1,465, respectively. The mining industry as a whole experienced 525 lost-time accidents, 7 of which were fatal; surface metal mining, underground metal mining, and underground nonmetal mining experienced 1, 3, and 3 fatal accidents, respectively. Coal mining experienced 23 lost-time accidents and no fatal accidents.

During 1976 active central mine rescue stations were located in Carlsbad, Grants, Lordsburg, and the Silver City-Vanadium area.

The State Inspector of Mines and his deputies performed 1,050 mine safety inspections during the year. Federal Mining Enforcement and Safety Administration (MESA) personnel monitored and assisted the State Inspector of Mines making numerous joint inspections. MESA personnel also investigated and wrote reports on seven fatal accidents and investigated one natural death that occurred on mining property. As of the end of 1976, 270 metal and nonmetal mines and 6 coal mines were active in New Mexico.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

New Mexico remained a major producer of mineral fuels and was a significant supplier of energy to other States during 1976. Mineral fuels comprised nearly three-quarters of the State's mineral output in terms of value and amounted to more than \$1.8 billion. Each mineral fuel increased in value during 1976 and represents a large proportion of the value of total mineral commodities produced in the State. Quantity of production of each mineral fuel, except for crude petroleum, increased from that of 1975.

The petroleum industry continued to be the greatest single source of tax revenue for the State; oil and gas production in 1976 generated nearly \$262 million in direct revenues. Of the 77.7 million acres in the State, nearly 1.6 million have been proved productive of oil and/or gas.

During 1976, a total of 1,223 wells were drilled, including 482 oil wells, 518 gas wells, and 223 dry holes. Drilling and completing these wells cost approximately \$233 million. Of 170 wildcat wells drilled during the year, 108 were dry holes. Total footage drilled by an average of 54 rotary rigs was more than 5.5 million feet, averaging 5,377 feet per well.

Coal.—Coal production increased by nearly 1 million tons from that of 1975 owing chiefly to an increase in demand for steam coal. The Four Corners powerplant of Arizona Public Service Co. solved most of the mechanical difficulties in operating the production units at levels whereby volume of emissions would meet stringent air quality regulations. Coal was produced at one strip mine and

one underground mine in Colfax County, two strip mines in McKinley County, and two strip mines in San Juan County.

Principal coal production was by Utah International, Inc., at its Navajo mine in San Juan County. The low-sulfur, high-ash coal was used at the Four Corners powerplant. The company also contracted coal for Western Coal Co. for use at the San Juan powerplant. According to Utah International's annual report, coal sales in 1976 were 6.5 million tons compared with 6.2 million tons in 1975. The present Navajo mine configuration has a capacity to produce approximately 8 million short tons of steam coal annually. Of the 1.1 billion tons of coal reserves at the Navajo mine recoverable by strip mining, less than one-third is committed to the Four Corners powerplant. Conditional commitment of the balance of the reserves to two utility companies would be used to produce pipeline-quality gas from the coal. Reclamation practices at the Navajo mine by company environmental engineers included the seeding of approximately 529 acres of land, using mostly native plant seed. Utah International, Inc., also operated the San Juan mine as a contractor for Western Coal Co. The coal was delivered to the nearby San Juan powerplant and tonnage reported for 1976 amounted to 1.2 million tons. Western Coal Co. also has a conditional option to purchase coal from Utah's Navajo mine to help fuel a portion of the requirements of additional proposed generating units at the San Juan powerplant. Production increased at the McKinley mine of the Pittsburg & Midway Coal Mining Co. where a \$100 mil-

lion expansion program was underway. One of two new 55-cubic-yard draglines being built at the mine went into service during the year with the second dragline scheduled for operation in 1977. Annual capacity of the mine is expected to be increased in 1979 to 5 million tons from the present 1 million tons. Most of the coal mined at the McKinley mine is shipped by rail to the Cholla powerplant in Joseph City, Ariz. New office, shop, crushing, and train loading complexes were completed in anticipation of use of a 100-car unit-train operation. The company's reclamation program continued to meet requirements of the State-enforced reclamation law.

Kaiser Steel Corp. continued to operate its underground York Canyon mine and its nearby West York strip mine. Longwall mining was continued in co-operation with the Federal Bureau of Mines. Reclamation requirements at the strip mines were met in accordance with State law.

The Sundance mine of Amcoal, Inc., was operated during 1976. The mine was sold in October 1975 to Amcoal, Inc., a subsidiary of Amcord Inc., of Riverside, Calif. The company was required to regrade and vegetate certain areas of the mine to conform with regulations administered by the Coal Surface Mining Commission.

No further developments have occurred relative to the Santa Fe Railway announcement during 1975 that a \$50 million, 70-mile stretch of new rail line would be built from Star Lake in the San Juan Basin to Santa Fe's main line near Prewitt about 16 miles west of Grants. Coal supposedly will be mined by Peabody Coal Co. from a strip mine located near Star Lake and will feed an electric gen-

erating plant near St. John's, Ariz. The proposed mine is estimated to be a \$65 million investment employing 200 people with approximately 125 acres per year to be mined. Each unit of the powerplant will require 4,000 tons of coal per day. Coal requirements for the first two units of the powerplant are approximately 86 million tons and the mine will supply the powerplant for its entire 35-year life.

Reclamation inspections at each of the five operating strip mines in New Mexico were made during April, July, and October by contracted officials for the New Mexico Coal Surface Mining Commission to insure each company's conforming to requirements of the State reclamation law.

Natural Gas.—Production of natural gas increased a little more than 1% in 1976 over that of 1975 and almost approximated the banner year of 1974. Value of production, however, increased 41% as the average price of natural gas rose to \$0.565 per thousand cubic feet. New Mexico ranked fourth among the 50 States in the production of natural gas. During 1976, 518 new gas wells were drilled and the total average cost per well was \$260,600. Production of more than 1.2 trillion cubic feet of natural gas in 1976 came from a total of 11,141 producing wells. At yearend, proved natural gas reserves amounted to almost 12 trillion cubic feet, unchanged from the year before.⁶ Production of natural gas came from State-owned land, 21%; Federal lands, 56%; Indian trust lands, 4%; and private lands, 19%. Direct revenues to the State from natural gas production increased 6.8% over that of 1975 and totaled \$51.8 million.⁷ Direct

⁶ New Mexico Oil and Gas Association. New Mexico Oil & Gas Facts, 1976, 3 pp.

⁷ New Mexico Oil & Gas Accounting Commission.

Table 4.—New Mexico: Coal (bituminous) production, by type of mine and county, 1976

(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines				Production (thousand short tons)			
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total
Colfax	2	1	--	3	W	W	--	W
McKinley	--	2	--	2	--	W	--	W
San Juan	--	2	--	2	--	W	--	W
Undistributed	--	--	--	--	1 W	9,760	--	9,760
Total	2	5	--	7	1 W	9,760	--	9,760

W Withheld to avoid disclosing company proprietary data.

¹ Included with strip total.

taxes were as follows: Emergency school tax, \$16.0 million; ad valorem production tax, \$7.5 million; conservation tax, \$1.1 million; severance tax, \$23.6 million; ad valorem equipment tax, \$1.2 million; and natural gas processor's tax, \$2.4 million. Of the 1.2 trillion cubic feet of natural gas produced in the State, about 0.1 to 0.2 trillion cubic feet or 10% to 15% was consumed in New Mexico.

Natural Gas Liquids.—Production of natural gas liquids increased 6.9% to 42.1 million barrels and increased in value 38.6% to \$231.9 million. A total of over 1 trillion cubic feet of gas was processed in 39 plants producing 49 million barrels of butane, propane, natural gasoline, and other products.

Estimates by the New Mexico Oil and Gas Association,⁸ as of January 1, 1977, indicated proved reserves of approximately 394 million barrels of natural gas liquids, an increase of 25 million barrels or nearly 7% from the 1975 estimate.

Petroleum.—Although production of petroleum in the State declined for the seventh consecutive year (3.1% less than in 1975), crude petroleum remained the largest single source of mineral value in New Mexico. Value of petroleum output increased 3.3% over that of 1975. The petroleum industry was the State's principal source of tax revenue and the largest nongovernmental employer.

Output of crude petroleum totaled 92,130,000 barrels and amounted to \$814.4 million in value, setting an alltime high value for this commodity in the State. New Mexico ranked sixth among crude petroleum-producing States in the Nation. According to the New Mexico Oil Conservation Commission, 16,977 oil wells in 802 reservoirs were in production during the year, a decrease of 138 wells, but an increase of 43 reservoirs. There were 3,226 injection wells in secondary recovery or pressure maintenance projects, an increase of 79 wells over that of 1975. The Permian Basin in southeast New Mexico remained the principal oil-producing area, accounting for more than 93% of the total production. Direct revenue to the State from petroleum production in 1976 totaled \$56.1 million, a decrease of 49% from that of 1975.⁹ Direct taxes were as follows: Emergency school tax, \$18.5 million; ad valorem production tax, \$7.7 million; conservation tax, \$1.3 million; severance tax, \$27.2 million; and ad valorem equipment tax, \$1.4 million.

Reported proved reserves of crude oil as of January 1, 1977,¹⁰ were 536 million barrels, down 52 million barrels from 1975, a decrease of 9%.

⁸ Work cited in footnote 6.

⁹ Work cited in footnote 7.

¹⁰ Work cited in footnote 6.

Table 5.—New Mexico: Production of crude oil and condensate, and natural gas, by county

County	Crude oil and condensate (thousand 42-gallon barrels)		Natural gas ¹ (million cubic feet)	
	1975	1976	1975	1976
Southeast New Mexico:				
Chaves	1,522	1,609	10,755	10,107
Eddy	23,650	24,050	253,070	256,708
Lea	62,153	59,111	416,129	413,463
Roosevelt	1,240	1,363	4,607	5,689
Total ²	88,565	86,132	684,561	685,967
Northwest New Mexico:				
McKinley	985	800	1,741	1,650
Mora	--	--	--	44
Rio Arriba	1,308	1,343	170,748	164,694
San Juan	3,934	3,397	345,031	361,966
Sandoval	270	456	1,026	992
Total ²	6,498	5,998	518,546	529,346
Grand total	95,063	92,130	1,203,107	1,215,313

^r Revised.

¹ Totals for natural gas differ from same totals in table 1. U.S. Bureau of Mines and the State of New Mexico use different pressure basis for natural gas statistics.

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

Source: New Mexico Oil Conservation Commission. 1976 Oil and Gas Statistics.

Table 6.—New Mexico: Oilfield and gasfield statistics, in 1976

	Southeast area	Northwest area	Total
Wells completed:			
Oil -----	431	51	482
Gas -----	187	331	518
Dry -----	150	73	223
Total -----	768	455	1,223
Service -----	16	2	18
Depleted wells abandoned:			
Oil -----	178	17	195
Gas -----	31	32	63
Service -----	100	2	102
Total -----	309	51	360
Number of pools:			
Oil -----	722	80	802
Gas -----	317	67	384
Total -----	1,039	147	1,186
Number of active wells:			
Oil -----	15,318	1,659	16,977
Gas -----	1,908	9,233	11,141
Injection -----	2,945	281	3,226
Total -----	20,171	11,173	31,344
Production from natural gas-processing plants:			
Natural gasoline ----- barrels	16,346,262	3,433,900	19,780,162
Butane ----- do	3,962,540	4,041,097	8,003,637
Propane ----- do	5,229,687	4,575,678	9,805,365
Composite liquids ----- do	2,446,423	9,423,117	11,869,540
Total liquids ----- do	27,984,912	21,473,792	49,458,704
Sulfur ----- long tons	27,450	--	27,450
Gas processed in plants, thousand cubic feet:			
Intake -----	577,930,091	426,334,153	1,004,264,244
Plant use -----	33,139,373	12,240,375	45,380,248
Shrinkage -----	52,510,808	17,676,853	70,187,661

Source: 1976 Report of New Mexico Oil Conservation Commission.

Table 7.—New Mexico: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Chaves -----	44	3	16	3	5	17	88	345,927
Eddy -----	141	58	29	6	18	32	284	1,654,533
Guadalupe -----	--	--	--	--	--	1	1	870
Harding -----	--	--	--	--	--	2	2	2,937
Lea -----	153	21	32	7	5	14	232	1,607,866
Lincoln -----	--	--	--	--	--	1	1	1,250
Luna -----	8	--	4	1	--	8	21	61,333
Mora -----	--	--	--	--	--	2	2	19,210
Quay -----	9	84	3	--	1	3	100	456,036
Rio Arriba -----	9	3	3	--	1	4	20	148,343
Roosevelt -----	2	9	2	--	2	16	31	117,438
Sandoval -----	19	135	24	--	5	11	194	711,561
Santa Fe -----	--	--	--	--	--	2	2	11,815
Sierra -----	--	--	--	--	--	2	2	3,617
Taos -----	--	--	--	--	--	2	2	11,427
Union -----	--	--	--	--	--	1	1	16,346
Total -----	385	313	113	17	37	113	983	5,170,559

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Secondary recovery techniques produced 24.0 million barrels or 26% of the State total oil production and 13.8 million barrels (15%) was from stripper wells. The average production of crude oil per well at the end of 1976 was 18.2 barrels per day, down 1.1 barrels per day

from 1975. A total of 360 depleted oil wells were abandoned during 1976.

Eight oil refineries, listed in the following tabulation, employed approximately 907 people during the year and were capable of processing approximately 114,000 barrels of oil per day:

Name	Location	Capacity (barrels per day)
Navajo Refining Co	Artesia	29,930
Famariss Oil & Refining Co	Monument	5,000
Shell Oil Co.—Ciniza	Gallup	18,000
Famariss Oil & Refining Co	Lovington	37,000
Plateau, Inc	Bloomfield	8,400
Caribou Four Corners Oil Co	Kirtland	2,300
Thriftway Oil Co	Bloomfield	7,500
Giant	do	6,200
Total		114,380

Forty-seven percent of the oil produced came from State-owned land, 32% from Federal land, 2% from Indian trust land, and 19% from private land.

During 1976, 482 new oil wells were drilled and the total average cost per well approximated \$202,500. Total costs for dry holes averaged \$235,000.

Of the 92.1 million barrels of crude oil produced in the State, only 29.7 million barrels or 32% were processed in New Mexico refineries. Nearly 44 million barrels of New Mexico crude oil (48%) was shipped to PAD District II for refining, and nearly 14 million barrels (15%) was refined in Texas.

Other Fuels.—Carbon dioxide and high-purity helium were also produced in New Mexico during 1976. Carbon dioxide was produced by S.E.C. Corp. of El Paso, Tex., at two plants in Harding County—one at Solano and one at Bueyeros. The company recovers carbon dioxide in the form of a gas from wells and pipes the gas to processing plants. The gas as recovered from the wells is better than 99% CO₂. The gas is converted to a liquid in the plants and is sold either as a liquid or as a solid (dry ice). S.E.C. Corp. employs 50 people at its plants and is the largest single industry in Harding County. Western Helium Co. operated a helium extraction plant in San Juan County. High-purity helium was recovered from a feedstock mixture of nitrogen and helium obtained from the Tocito field.

METALS

The value of metal production increased to \$481.8 million, nearly 34% more than the \$360.1 million in 1975. Principal cause of the increase was a large increase in the production of copper and uranium attended by an increase in the price of copper from \$0.64 to \$0.70 per pound and in the price of uranium from \$12.30 to \$16.10 per pound. Demand for copper increased slightly although worldwide copper inventories continued to climb to record levels. Copper remained the principal metal produced, accounting for nearly 50% of the total metal value in the State. Uranium value was nearly 40% of the total metal value. Other metals produced in New Mexico in 1976 were gold, iron ore, lead, manganiferous ore, molybdenum, silver, tin, vanadium, and zinc.

Copper.—Total copper production in 1976 increased 26,097 tons in quantity and \$52.1 million in value from that of 1975. The State continued to rank third in total copper production behind Arizona and Utah. Copper was produced at 10 mines in 5 counties of the State. Three mines in Grant County and one each in Hidalgo, Sandoval, and Santa Fe Counties produced copper as the primary metal. Several other companies in Grant County produced copper as a byproduct from other metal mining and by leaching. The Chino mine of Kennecott Copper Corp. near Santa Rita and the Tyrone mine of Phelps-Dodge

Table 8.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ¹	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold, silver, and gold-silver ^{2,3} -----	5	14,359	1,817	14,628	10	W	W
Copper, lead, and zinc ² ----	7	25,146,847	13,339	877,304	149,961	W	W
Total -----	12	25,161,206	15,156	891,932	149,971	W	W
Other lode material:							
Copper precipitates ----	5	28,227	--	--	22,389	--	--
Total lode material ----	12	25,189,433	15,156	891,932	172,360	W	W
Placer -----	1	--	42	--	--	--	--
Grand total -----	13	25,189,433	15,198	891,932	172,360	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 material that was leached.

Table 9.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing ¹		Material sold or treated (short tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1974, total -----	16	--	26,557,948	15,427	\$2,464,310	1,194,800	\$5,627,508
1975, total -----	10	--	19,586,150	15,049	2,430,263	792,050	3,500,862
1976:							
Grant -----	6	--	25,162,212	13,578	1,701,594	886,261	3,855,236
Hidalgo -----	1	--	123	5	627	1,859	8,037
Sierra -----	1	1	142	49	6,140	538	2,340
Socorro -----	1	--	150	1	125	83	361
Undistributed ² ----	3	--	26,801	1,565	196,125	3,191	13,881
Total -----	12	1	25,189,433	15,198	1,904,611	891,932	3,879,905
1976: (continued)							
	Copper		Lead		Zinc		Total value
	Short tons	Value	Short tons	Value	Short tons	Value	
1974, total -----	196,585	\$303,920,197	2,364	\$1,063,806	13,784	\$9,896,672	\$322,972,493
1975, total -----	146,263	187,801,710	1,931	830,492	11,015	8,591,884	203,155,211
1976:							
Grant -----	172,298	239,838,265	W	W	W	W	245,395,095
Hidalgo -----	(³)	139	--	--	--	--	8,853
Sierra -----	(³)	122	--	--	--	--	8,602
Socorro -----	--	--	W	W	--	--	486
Undistributed ² ----	62	86,526	--	--	--	--	296,532
Total -----	172,360	239,925,052	W	W	W	W	245,709,568

W Withheld to avoid disclosing company proprietary data; not included in total.

¹ Plants leaching runoff water not counted as producing mines.

² Includes Sandoval, Santa Fe, and Valencia Counties combined to avoid disclosing company proprietary data.

³ Less than 1/2 unit.

Table 10.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Zinc (short tons)	Lead (short tons)
Lode:					
Cyanidation and smelting of concentrates ¹ -----	14,308	878,602	149,949	W	W
Direct smelting of--					
Ore -----	848	13,330	22	W	W
Precipitates -----	--	--	22,389	--	--
Total -----	848	13,330	22,411	W	W
Total lode material -----	15,156	891,932	172,360	W	W
Placer -----	42	--	--	--	--
Grand total -----	15,198	891,932	172,360	W	W

W Withheld to avoid disclosing company proprietary data.

¹ Combined to avoid disclosing company proprietary data.

Corp. near Tyrone, both in Grant County, were the leading copper-producing facilities in the State.

The Nacimiento mine of Earth Resources Co. remained closed because of the depressed copper prices. The remaining ore reserves will be held in anticipation of higher copper prices. The 85 mine and the Bonney mine of Federal Resources Corp. remained on a standby basis until such time as the copper price trend could be evaluated.

Although a supplementary control system for regulating SO₂ emissions was installed and began operating in August of 1975 at the Hurley smelter, particulate emissions from the smelter could not be limited to 0.03 grain per average sampled cubic foot of discharge gas as required by regulations. In December, the Environmental Improvement Board extended the deadline to June 30, 1978, for Kennecott's Hurley smelter to meet the strict regulations on emission. Operations at Chino continued on a reduced operating level and copper production was 57,200 tons compared with 53,200 tons in 1975. The company gained access during the year to outside electric power when a connection was completed between its powerplant and a public utility company whereby significant amounts of low-cost off-peak power can be purchased.

Occidental Minerals Corp. (OXYMIN) started preparations for a pilot test including fragmentation of a porphyry copper deposit, located approximately 6 miles north of Cerrillos, for a possible in situ leaching operation. Feasibility of commer-

cial development will be determined following evaluation of test results.

Construction of the Phelps-Dodge Corp.'s \$268 million copper smelter in Hidalgo County was completed and production started on July 1. The flash smelting process in the new smelter produces furnace gas streams with higher concentrations of SO₂ than gas streams from reverberatory furnaces, thereby making it possible to remove sulfur either as elemental sulfur or as sulfuric acid. The smelter produced 37,944 tons of copper anodes during 1976 from copper concentrates mainly from the company's Tyrone operation. Anode production at the smelter was shipped to the company refinery at El Paso, Tex. During 1976, the company began installing a second acid plant at the smelter to enable treatment of output from Cyprus Mines Corp. beginning in 1978. In 1976 the copper mine at Tyrone produced 183.2 million pounds of recoverable copper in concentrates, ores, and precipitates compared with 150.8 million pounds in 1975. Average grade of ore mined in 1976 was 0.82% copper compared with 0.81% in 1975. In March, work schedules at the Tyrone mine and concentrator were increased from 5 to 6 days until December when they were reduced to a 5½-day week.

UV Industries, Inc., produced 668,435 tons of ore with an average copper assay of 1.66% from its underground mine and produced 1,650,352 tons of ore with an average copper assay of 0.83% from its open pit mine. Two flotation mills treated more than 2.4 million tons from which 88,862

tons of copper concentrates averaging 26% copper were produced. The concentrates were processed by custom smelters. According to the company's annual report, as of December 31, 1976, copper ore reserves in the underground mine were estimated to be 18.9 million tons averaging 1.96% copper with estimated recoverable tons being about 16.5 million. Open pit estimated recoverable reserves were 18.8 million tons assaying an average of 0.88% copper.

Gold.—Production of gold came from seven mines operated by seven companies in Grant County and from one mine each in Hidalgo, Sandoval, Santa Fe, Sierra, Socorro, and Valencia Counties. Most of the production came from Grant County and was a result of byproduct recovery from copper mining. The quantity of gold produced in 1976 was 149 troy ounces more but \$525,000 less than that of 1975. The average price of gold in 1976 was \$125.34 per ounce compared with \$161.47 in 1975.

Iron Ore.—UV Industries, Inc., produced magnetite as a byproduct at its Continental copper mine in Grant County.

Lead and Zinc.—The Ground Hog mine operated by ASARCO, Inc., in Grant County was the leading producer of lead and zinc in New Mexico during 1976. Four other companies also produced lead and zinc in Grant County, and production was also reported in Socorro County by New Mexico Spar Co.

Quantity and value of production of lead increased above that of 1975. The average price of lead produced in New Mexico during the year was \$0.231 per pound. Quantity and value of zinc production also increased above that of 1975. The average price of zinc produced in New Mexico during the year was \$0.37 per pound.

The Ground Hog mine of ASARCO, Inc., achieved its second highest tonnage in its history. Expanded use of trackless mining methods was chiefly responsible for the increased tonnage.

Molybdenum.—Principal production of molybdenum came from the Questa mine of Molycorp. Similar molybdenum concentrates were produced by Kennecott Copper Corp. as a byproduct at its Hurley copper concentrator. Kerr-McGee Corp. also produced a molybdenum byproduct during uranium concentration at its Ambrosia Lake milling operation.

According to Molycorp's 1976 annual report, the company produced 11.5 million pounds of molybdenum contained in molybdenum disulfide concentrates during the year, 0.4 million pounds more than in 1975. Kennecott Copper Corp. and Molycorp, continued exploratory and feasibility studies of developing an underground deposit at Molycorp's Questa property.

Silver.—Production of silver came chiefly as a byproduct of copper, lead, and zinc mining and processing. Major producers in order of rank were Phelps-Dodge Corp., UV Industries, Inc., and ASARCO, Inc., all in Grant County. Other producers in Grant County were Kennecott Copper Corp., C. F. Hanson, and Dresser Industries, Inc. Silver was also produced by one company each in Hidalgo, Santa Fe, Sierra, Socorro, and Valencia Counties. Silver production increased 100,000 troy ounces (13%) and nearly \$0.4 million (11%) in value from that of 1975.

Uranium.—New Mexico retained its position as the leading producer of uranium in the United States, accounting for 47% of the U.S. total. Total production of uranium oxide (U_3O_8) amounted to 11,880 million pounds, recovered from 3,321 million tons of ore.

Reported production came from 23 mines in McKinley County and 5 mines in Valencia County. One other mine in McKinley County recovered uranium from in situ leaching. Ore was mined by seven companies and processed in four uranium processing mills having a nominal capacity of 15,160 tons of ore per day. Three mills located in the Ambrosia Lake district in McKinley County are operated by Kerr-McGee Corp., United Nuclear Corp., and The Anaconda Company. A fourth mill located in Valencia County was operated by Sohio Petroleum Co. A small quantity of ore was shipped to Colorado for processing. Most of the ore, however, was processed at the Kerr-McGee mill. The average price of the U_3O_8 (yellowcake) produced during the year was \$16.10 per pound.

The Anaconda Company continued its gradual phasing out until the year 1979 of the open pit mining operations at the Jackpile and Paguate mines located on the Laguna Indian Reservation. Limited underground production continued at the company's new P-10 mine.

The Anaconda Company applied for an air quality permit in connection with the proposed expansion of its uranium mill at Bluewater. Costs were estimated from \$10 to \$20 million and the expansion would more than double the mill's capacity. Construction was slated to begin in 1977 if the permit is issued by the Environmental Improvement Agency.

Gulf Mineral Resources Co. continued progress during 1976 in development work at its Mount Taylor underground uranium mine. The service shaft had reached a depth of approximately 1,000 feet and the production shaft reached 900 feet at year-end. Target depth of 3,500 feet should be reached by 1979. Total investment in the completed project was estimated at \$400 million. Shaft sinking continued at the company's smaller and shallower Mariano mine where production is scheduled to begin in late 1977. The company continued exploration drilling on other properties in New Mexico along the Grants Uranium Belt in the same area as the Mount Taylor and Mariano projects.

Uranium production at Kerr-McGee's principal mining operations in the Ambrosia Lake area increased over that of 1975. Production from the Church Rock No. 1 mine northeast of Gallup increased as development work begun in 1975 continued. Ore from the mine was processed at the 7,000-ton-per-day company mill near Grants. Delineation drilling was completed on three other projects at Roca Honda in eastern Ambrosia Lake, at Rio Puerco, and at a second mine at Church Rock.

In 1977, Phillips Petroleum Co. planned to sink the first of four 3,400-foot-deep shafts on property where the company made a significant uranium discovery near the Seven Lakes Region located about 12 miles northeast of Crownpoint. Drilling indicated the presence of 25 million pounds of uranium oxide in an area of about 1,900 acres within 43,000 acres of the company's full interest, options, and claims in McKinley County. Construction of a mill is expected to begin in 1978 and production from the mine is expected to start in the early 1980's.

Ranchers Exploration & Development Corp. continued development of its Johnny M. mine throughout the year; although production began in 1976, progress was slower than expected and only about 16,000

tons of low-grade ore was produced. Erratic ore deposition combined with a shortage of experienced miners made the mining more difficult and expensive. Expected tonnage when the mine is in full operation is 650 tons per day. The company began sinking of a shaft at its Hope mine near Ambrosia Lake and the 8-foot-diameter shaft was bottomed at 465 feet in September. In place reserves at this mine are estimated at about 224,000 tons of ore containing 826,000 pounds of U_3O_8 .

Sohio Petroleum Co. was 50% owner and operating manager for uranium properties located on the L-Bar Ranch about 50 miles west of Albuquerque. An underground mine and uranium processing mill began operating in 1976. The mine will produce about 25,000 tons of ore per month and the mill will have a nominal capacity of 1,660 tons per day. The ore body is estimated to contain 5.3 million tons averaging 0.19% U_3O_8 and occurs at depths of 250 to 650 feet. Ore from nearby mines as well as the Sohio-operated mine will be processed at the mill. About 2 million pounds of uranium concentrates is the expected output of the mill, 70% of which will be from the company-owned mine.

Uranium was produced by United Nuclear Corp. from its own mines and from mines operated by United Nuclear-Homestake Partners. Including United Nuclear's share of the partnership production, total uranium production for the year was approximately 2 million pounds of U_3O_8 , or 33% greater than that of 1975. United Nuclear operated the Section 27 and Sandstone mines by conventional mining methods and the Ann Lee mine by solution mining. The Church Rock mine became the company's largest uranium producer. Development of a second production shaft was scheduled for completion before the end of the year. The new uranium mill located at Church Rock is scheduled for completion in 1977. Production from mines at Ambrosia Lake is expected to continue at a rate in excess of 1 million pounds per year. According to the company annual report, uranium reserves calculated at a \$20-per-pound cutoff cost were 26.5 million tons of ore averaging 0.153% U_3O_8 , or 82.2 million pounds of U_3O_8 .

Mining operations continued during the year at United Nuclear-Homestake Partners' four underground mines and leaching

operations. Late in 1976 mining operations at Homestake's F-33 mine were terminated when retreat mining was completed and the mine's ore reserves were exhausted. Metallurgical recoveries were higher than those achieved during 1975 and production of uranium concentrates was up 22% in 1976.

With a 45% interest in a joint venture, Western Nuclear, Inc., a 100% owned subsidiary of Phelps-Dodge Corp., continued the development phase of the underground Ruby No. 1 uranium mine near Grants. Production during development in 1976 amounted to 178,600 pounds of U_3O_8 . The company drilled three other uranium prospects in the area near Grants during the year with satisfactory results.

Reserve Oil & Minerals Corp. sold 50,000 pounds of uranium concentrates for \$42.25 per pound to an unnamed utility company.

A U.S. District Judge denied a preliminary injunction sought by 17 Navajos to prohibit Interior Secretary Kleppe from approving an environmental impact statement for a proposed uranium development area on Navajo land. An exclusive agreement with Exxon was signed in 1975 by the Navajo Tribal Council whereby Exxon was granted a prospecting permit, a mining lease agreement, an operating schedule for execution of the lease, and a surface mining lease.

Other Metals.—Manganiferous ore, tin, and vanadium were also produced in New Mexico during 1976. Manganiferous ore production decreased by 4,614 tons (9.2%) and decreased 23.4% in value. Tin production declined by half and value decreased 9.2% from that of the previous year. Vanadium production and value doubled over that of 1975.

NONMETALS

Value of nonmetals production decreased 3% to \$215.3 million and represented 8.6% of the State's total mineral production value. The most valuable nonmetallic mineral produced in New Mexico continued to be potash (potassium salts) as its share in value of the total nonmetals output was nearly 77%. Other nonmetallic minerals produced in descending order of value were sand and gravel, cement, perlite, stone, lime, pumice, salt, gem stones, gypsum, and clays.

Cement.—Ideal Cement Co., a division of Ideal Basic Industries, Inc., was the State's only cement producer at its plant located at Tijeras, east of Albuquerque in Bernalillo County.

Clays.—Six operations produced clay and shale during 1976. Two mines were operated in Bernalillo County and one mine each was operated in Dona Ana, Hidalgo, Luna, and San Juan Counties. Production and value of clay increased substantially from that of 1975. The Federal Bureau of Mines ran extrusion tests on several clay samples submitted by the New Mexico Bureau of Mines and Mineral Resources.

Gypsum.—White Mesa Gypsum Co. and Duke City Gravel Products Co. mined gypsum in Sandoval County. Output continued to decline substantially again in 1976. American Gypsum Co. calcined gypsum at Albuquerque in Bernalillo County.

Lime.—Mathis Mining & Exploration Co. and Kennecott Copper Corp. produced lime in Grant County during the year.

Mica.—Only one mica mine was active in the State during 1976, that of the Mineral Industrial Commodities of America, Inc., located in Taos County.

Perlite.—Production of perlite increased by 52,000 tons and value increased more than \$2 million over that of 1975. New Mexico continued to lead the Nation with 87% of total crude perlite production. Johns-Manville Perlite Corp. at its Seven Hills mine and Grefco, Inc., at its El Grande mine, both in Taos County, were the two largest producers in the State. Additional production came from Silbrico Corp. in Taos County and United States Gypsum Co. in Valencia County. Production was started by Grefco, Inc., at its mine and plant near Socorro in Socorro County and output was the third largest in the State. The perlite deposit near Socorro is estimated to be in excess of 10 million tons.

Potash.—New Mexico remained the leading producer of potash in the Nation, contributing 83% of total U.S. output in 1976. Seven companies were engaged in potash production in Eddy County and one company produced potash in Lea County. Although total production in New Mexico increased by 2,000 tons, value of production decreased 8% to \$165 million

when the average price of potash dropped from \$86.46 per ton in 1975 to \$79.38 per ton in 1976.

AMAX Chemical Corp. invested \$1 million in capital facilities to convert lower-priced standard product and otherwise lost partides of potash into granular grade. Granular capacity will expand by 20% when the project is completed in 1977. Duval Corp. commenced production from a new mine in March whereby muriate of potash production is expected to increase to 350,000 tons per year. The company has washed langbeinite capacity in New Mexico of 325,000 tons per year. Sales during 1976 totaled 478,000 tons, approximately 25% more than that of 1975.

International Minerals & Chemical Corp. produced 213,000 tons of muriate potash and 542,000 additional tons of specialty potash.

Kerr-McGee Corp. officials estimated that potash ore reserves will support the company's \$42 million investment in mining and milling facilities in New Mexico for another 25 years.

Mississippi Chemical Co. increased potash production in 1976 and projected production at the Carlsbad facility will supply one-third of Mississippi Chemical's anticipated annual requirements.

National Potash Co. shut down its Eddy County mine in November when recovery of all available ore was completed. The company shifted mining operations from its depleted Eddy County mine to its original mine in Lea County where ultimate capacity of about 390,000 tons of product annually is to be expected. The company began a program to improve current production and to minimize operating costs.

Potash production at the Potash Co. of America (PCA) was down approximately 11% from that of 1975 in accordance with a plan to control inventories. The company completed a reevaluation of ore reserves that indicates reserves are adequate for approximately 11 years at current rates of production.

Pumice.—In terms of output tonnage, New Mexico ranked fourth in the Nation in the production of pumice¹¹ with both production and value increasing from that of 1975. During 1976, 10 operations in 7 counties included 11 mines and 6 processing plants. The largest producers in the State were Twin Mountain Rock Co. in Union County, General Pumice Corp. in Rio Arriba County, and Morton Bros. in Dona Ana County.

¹¹ Statistics designated "pumice" include such volcanic materials as scoria and volcanic cinders.

Table 11.—New Mexico: Production and sales of potassium salts
(Thousand short tons and thousand dollars)

Period	Crude salts ¹ (mine production)		Marketable potassium salts					
	Gross weight	K ₂ O equivalent	Production		Sold or used			
			Gross weight	K ₂ O equivalent	Gross weight	K ₂ O equivalent	Value ²	
1975:								
January-June ----	9,156	1,402	2,037	1,079	1,608	846		73,988
July-December ---	8,653	1,298	1,817	1,002	1,618	903		76,634
Total -----	17,809	2,700	3,854	2,081	3,221	1,749		150,622
1976:								
January-June ----	8,583	1,289	1,876	1,005	2,069	1,098		92,744
July-December ---	8,725	1,271	1,834	984	1,820	985		72,610
Total -----	17,308	2,560	3,710	1,989	3,889	2,083		165,354

¹ Revised.

² Sylvinite and langbeinite.

³ F.o.b. mine.

Salt.—Salt was produced in various forms and continued to be a major byproduct of the potash industry. A total of five active operations reported production for 1976; four operations were in Eddy County and the fifth operation was in Catron County. Although salt production quantity decreased, value increased from that of 1975.

Sand and Gravel.—Production of sand and gravel remained the most widespread mining activity in the State. Sand and gravel was mined by 91 companies at 130 separate operations in 29 counties of the State. No production was reported for Harding, Los Alamos, and Roosevelt Counties. Production of sand and gravel increased by 1,482,000 tons and value of production increased nearly 21% over that of 1975 to \$16.7 million. The average unit value of sand and gravel produced in New Mexico during 1976 was \$2.16 per ton. Commercial operations accounted for 4.4 million tons, 56% of the total State output; government operations accounted for the remainder. Most of the sand and gravel produced was used for road construction.

More than 89% of all the sand and gravel produced was processed before use.

Stone.—Stone production decreased 12% in quantity and 6% in value from that of 1975. In 1976, five companies quarried dimension stone for rubble, rough construction, and other uses. Nineteen companies crushed stone at 35 quarries for cement, roadbase aggregates, bituminous aggregate, and other uses. Compared with those in 1975, five fewer quarries were in operation during the year. The average price per ton of stone rose from \$2.13 in 1975 to \$2.27 in 1976.

Other Nonmetals.—Gem stones and byproduct sulfur were also produced in New Mexico during 1976. Raw turquoise was purchased out-of-State and sold either as raw or polished turquoise within New Mexico. Elemental sulfur was recovered as a byproduct of natural gas processing at plants located in Eddy, Lea, and Roosevelt Counties. In 1976, five companies produced a total of 45,060 long tons and sold or used 45,144 long tons having a total value of \$1.48 million or an average value of \$32.78 per long ton.

Table 12.—New Mexico: Construction sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	3,069	\$6,335	\$2.06
Gravel -----	4,632	10,336	2.23
Total -----	¹ 7,702	16,671	2.16

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

Table 13.—New Mexico: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) ---	3,283	\$7,850	\$2.39
Concrete products (cement blocks, bricks, pipe, etc.) ---	380	1,376	3.62
Asphaltic concrete aggregate and other bituminous mixtures -----	1,171	3,002	2.56
Roadbase and coverings -----	1,965	3,241	1.65
Fill -----	585	918	1.57
Other uses -----	317	284	.90
Total -----	¹ 7,702	16,671	2.16

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

Table 14.—New Mexico: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	280	554	381	674
Bituminous aggregate -----	456	953	238	535
Flux stone -----	116	215	146	291
Roadstone -----	139	268	128	169
Fill -----	--	--	114	171
Surface treatment aggregate -----	140	302	104	196
Macadam aggregate -----	--	--	84	84
Lime manufacture -----	57	W	70	W
Concrete aggregate -----	55	84	W	W
Agricultural limestone -----	--	--	4	13
Riprap and jetty stone -----	421	690	--	--
Other uses ² -----	523	1,530	652	2,156
Total ³ -----	2,188	4,598	1,921	4,289

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

¹Includes limestone, sandstone, traprock, granite, and miscellaneous stone.

²Includes stone used in cement manufacture, terrazzo and exposed aggregate, and uses indicated by symbol W.

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

Table 15.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon dioxide (natural): S.E.C. Corp -----	Box 9737 El Paso, Tex. 79987	Well and extraction plant.	Harding.
Cement: Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Dry process, 2 rotary kiln plant.	Bernalillo.
Clays: El Paso Brick Co -----	Box 12336 El Paso, Tex. 79912	Open pit mine ----	Dona Ana.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	----do -----	Bernalillo.
Kinney Brick Co., Inc ----	Box 1804 Albuquerque, N. Mex. 87102	----do -----	Do.
Coal: Amcoal, Inc -----	Box 832 Riverside, Calif. 92502	Strip mine -----	McKinley.
Kaiser Steel Corp -----	Box 58 Oakland, Calif. 90604	Underground mine, strip mine, crushing plant, dense media-froth flotation cleaning plant.	Colfax.
Pittsburg & Midway Coal Mining Co.	1600 Tenmain Center Kansas City, Mo. 64106	Strip mine, crush- ing plant, chemi- cal and water treatment plant.	McKinley.
Utah International, Inc ----	550 California St. San Francisco, Calif. 94104	Strip mine, crush- ing plant, dust suppression de- tergent treatment plant.	San Juan.
Western Coal Co -----	Box 1026 Albuquerque, N. Mex. 87103	Strip mine -----	Do.
Copper: Kennecott Copper Corp., Chino Mines Div.	Hurley, N. Mex. 88043 -----	Open pit mine, flotation mill, precipitation plant, smelter.	Grant.
Phelps-Dodge Corp., Tyrone Branch. ¹	Drawer B Tyrone, N. Mex. 88065	Open pit mine and mill.	Do.
UV Industries, Inc. ² -----	136 East South Temple St. Salt Lake City, Utah 84111	Underground mine, open pit mine, flotation mill.	Do.

See footnotes at end of table.

Table 15.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Gypsum:			
Duke City Gravel Products Co.	Gun Club Rd., SW. Albuquerque, N. Mex. 87105	Open pit mine ----	Sandoval.
White Mesa Gypsum Co ----	124 Jackson, NE. Albuquerque, N. Mex. 87108	----do -----	Do.
Lead: ASARCO, Inc -----	Box 186 Vanadium, N. Mex. 88773	Underground mine and shaft.	Grant.
Lime:			
Kennecott Copper Corp., Chino Mines Div.	Hurley, N. Mex. 88043 ----	Rotary-kiln plant..	Do.
Mathis Mining & Explora- tion Co.	1101 Santa Rita Silver City, N. Mex. 88061	Quarry, open pit mine.	Do.
Mica:			
Mineral Industrial Com- modities of America, Inc.	Box 2408 Santa Fe, N. Mex. 87501	Open pit mine ----	Taos.
Molybdenum:			
Molybdenum Corp. of America, Questa Div.	280 Park Ave. New York, N.Y. 10017	Open pit mine and flotation mill.	Do.
Natural gas and petroleum: *			
Perlite:			
Grefco, Inc., Dicalite Div --	333 North Michigan Ave. Chicago, Ill. 60601	Open pit mine; crushing, screen- ing, air separa- tion.	Do.
Johns-Manville Perlite Corp.	2500 Miguelito Rd. Lompoc, Calif. 93436	----do -----	Do.
Potash:			
AMAX Chemical Corp ----	Box 279 Carlsbad, N. Mex. 88220	Underground mine and refinery.	Eddy.
Duval Corp., Potash Div----	Box 511 Carlsbad, N. Mex. 88220	2 underground mines and refinery.	Do.
International Minerals & Chemical Corp.	Box 71 Carlsbad, N. Mex. 88220	Underground mine.	Do.
Kerr-McGee Corp -----	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	----do -----	Do.
Mississippi Chemical Co --	Box 101 Carlsbad, N. Mex. 88220	1 underground mine.	Do.
National Potash Co -----	Box 731 Carlsbad, N. Mex. 88220	----do -----	Do.
Potash Co. of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, N. Mex. 88220	----do -----	Do.
Pumice:			
General Pumice Corp ----	Box 449 Santa Fe, N. Mex. 87501	Open pit mine and crushing and screening plant.	Rio Arriba.
Morton Bros -----	Box 2000 Las Cruces, N. Mex. 88001	----do -----	Dona Ana.
Twin Mountain Rock Co --	Box 1009 Sheridan, Wyo. 82801	----do -----	Union.
Salt:			
Mississippi Chemical Co --	Box 101 Carlsbad, N. Mex. 88220	Solar evaporation -	Eddy.
Potash Co. of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, N. Mex. 88220	Tailings salt ----	Do.
Sand and gravel (commercial):			
Albuquerque Gravel Products Co.	Box 829 Albuquerque, N. Mex. 87103	Stationary plant --	Bernalillo.
Alcora Materials Co -----	Box 2439 Farmington, N. Mex. 87401	Portable plants ---	San Juan.
Jones Construction Co ----	Box 803-A Albuquerque, N. Mex. 87103	----do -----	Sandoval and Santa Fe.
Rose Gravel -----	1400 San Jose Blvd. Carlsbad, N. Mex. 88220	1 stationary and 2 portable plants.	Eddy.
San Juan Concrete -----	507 South Behrend Ave. Farmington, N. Mex. 87401	Portable plant and crushing pit.	San Juan.
Springer Corp -----	Box 572 Albuquerque, N. Mex. 87103	Pit and stationary crushing and screening plant.	Bernalillo.

See footnotes at end of table.

Table 15.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
G. F. Atkinson Co -----	Box W Albuquerque, N. Mex. 87103	Quarry -----	Sandoval.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Quarry and plant -	Bernalillo.
New Pueblo Constructors, Inc.	Box 430 Tijeras, N. Mex. 87059	Quarry -----	Do.
Wylie Bros. Contracting Co.	Box 8526 Albuquerque, N. Mex. 87108	Open pit -----	Otero.
Uranium:			
The Anaconda Company, New Mexico Operations.	Box 638 Grants, N. Mex. 87020	Open pit mine and acid-leach process mill.	Valencia.
Kerr-McGee Corp -----	Box 218 Grants, N. Mex. 87020	6 underground mines and acid- leach process mill.	McKinley.
United Nuclear Corp -----	Box 3951 Albuquerque, N. Mex. 87110	6 underground mines and alka- line-leach process mill.	Do.

¹ Also gold, molybdenum, and silver.² Also gold and silver.³ Most of the major oil and gas companies operate in New Mexico and several commercial directories contain complete lists of them.

The Mineral Industry of New York

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the New York State Museum and Science Service for collecting information on all minerals except fuels.

By L. F. Heising ¹

The value of New York's mineral output was \$428.0 million, an increase of \$30.2 million over that of 1975. New York was the sole producing State for aluminum-zirconium oxide, emery, and wollastonite in 1976. The State ranked first nationally in the production of aluminum oxide abrasives and synthetic calcium chloride; and

ranked third in the production of talc, ilmenite, and zinc. The State continued to be an important producer of cement, gypsum, salt, sand and gravel, stone, and garnet.

¹ State Liaison Officer, Bureau of Mines, Albany, N.Y.

Table 1.—Mineral production in New York ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ²thousand short tons..	817	\$1,561	649	\$2,089
Gem stones	NA	16	NA	15
Lead (recoverable content of ores, etc.)				
.....short tons..	3,027	1,302	3,196	1,476
Natural gasmillion cubic feet..	7,628	5,645	9,235	10,486
Peatthousand short tons..	22	377	32	684
Petroleum (crude) ..thousand 42-gallon barrels..	875	10,693	857	10,497
Saltthousand short tons..	5,978	57,344	6,485	66,441
Sand and graveldo..	22,158	44,064	27,881	56,132
Silver (recoverable content of ores, etc.)				
.....thousand troy ounces..	56	248	49	214
Stonethousand short tons..	31,713	80,929	28,136	75,040
Zinc (recoverable content of ores, etc.)				
.....short tons..	76,612	59,757	78,671	54,517
Value of items that cannot be disclosed:				
Cement, clays (ball), emery, garnet (abrasive), gypsum, iron ore, lime, mercury, talc, titanium concentrate (ilmenite), and wollastonite	XX	135,792	XX	150,423
Total	XX	397,728	XX	427,964
Total 1967 constant dollars	XX	157,881	XX	^p 153,853

^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 ball clay; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in New York, by county^{1 2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Albany -----	W	W	Cement, stone, clays, sand and gravel.
Allegany -----	W	W	Petroleum, sand and gravel, natural gas.
Broome -----	\$956	\$2,081	Sand and gravel, clays, stone, peat.
Cattaraugus -----	10,767	W	Petroleum, sand and gravel, natural gas.
Cayuga -----	W	W	Sand and gravel, natural gas, stone.
Chautauqua -----	4,192	8,218	Natural gas, sand and gravel, petroleum.
Chemung -----	W	1,297	Sand and gravel.
Chenango -----	602	464	Do.
Clinton -----	W	W	Stone, sand and gravel.
Columbia -----	12,868	10,893	Cement, stone, sand and gravel, clays.
Cortland -----	706	1,061	Sand and gravel.
Delaware -----	W	W	Stone, sand and gravel.
Dutchess -----	15,979	W	Stone, sand and gravel, peat.
Erie -----	13,368	14,760	Stone, lime, sand and gravel, natural gas, clays.
Essex -----	12,289	11,721	Titanium concentrates, wollastonite, iron ore, stone, sand and gravel.
Franklin -----	W	W	Sand and gravel, stone.
Fulton -----	W	401	Sand and gravel.
Genesee -----	W	W	Stone, gypsum, sand and gravel, natural gas.
Greene -----	W	W	Cement, stone, sand and gravel.
Herkimer -----	W	W	Sand and gravel, stone.
Jefferson -----	1,406	2,008	Stone, sand and gravel.
Lewis -----	517	962	Sand and gravel, stone.
Livingston -----	W	W	Salt, sand and gravel, stone, natural gas.
Madison -----	W	W	Stone, sand and gravel, natural gas.
Monroe -----	W	W	Do.
Montgomery -----	W	1,677	Stone, sand and gravel.
Nassau -----	W	W	Sand and gravel, clays.
Niagara -----	4,536	W	Stone.
Oneida -----	W	W	Stone, sand and gravel.
Onondaga -----	29,587	36,546	Lime, stone, cement, salt, sand and gravel, clays.
Ontario -----	W	W	Sand and gravel, stone, natural gas.
Orange -----	W	W	Sand and gravel, stone, peat.
Orleans -----	W	W	Stone, sand and gravel.
Oswego -----	709	1,335	Sand and gravel.
Otsego -----	W	189	Do.
Putnam -----	W	W	Stone.
Rensselaer -----	W	W	Sand and gravel, stone.
Richmond -----	W	---	
Rockland -----	5,268	W	Stone, sand and gravel.
St. Lawrence -----	81,186	78,169	Zinc, iron ore, stone, lead, talc, sand and gravel, silver.
Saratoga -----	2,372	2,432	Stone, sand and gravel.
Schenectady -----	728	W	Sand and gravel.
Schoharie -----	W	W	Stone, cement, clays, sand and gravel.
Schuyler -----	W	W	Salt, sand and gravel.
Seneca -----	W	W	Stone, natural gas, sand and gravel, peat.
Steuben -----	3,930	5,552	Natural gas, sand and gravel, stone, petroleum.
Suffolk -----	4,179	4,798	Sand and gravel.
Sullivan -----	W	W	Stone, sand and gravel.
Tioga -----	1,932	1,956	Sand and gravel.
Tompkins -----	W	W	Salt, stone, sand and gravel.
Ulster -----	W	W	Cement, stone, sand and gravel, clays.
Warren -----	9,178	11,284	Cement, garnet, stone, sand and gravel.
Washington -----	1,254	1,435	Stone, sand and gravel.
Wayne -----	W	W	Do.
Westchester -----	388	213	Stone, emery, peat, sand and gravel.
Wyoming -----	W	W	Salt, natural gas.
Yates -----	W	W	Salt, sand and gravel.
Undistributed ³ -----	178,830	228,512	
Total -----	⁴ 397,728	427,964	

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

¹ Bronx, Hamilton, Kings, New York, and Queens Counties are not listed because no production was reported.

² Values of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

³ Includes gem stones and sand and gravel 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.

Table 3.—Indicators of New York business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands---	7,668.0	7,735.0	+ .9
Unemployment -----do-----	730.0	794.0	+ 8.8
Employment (nonagricultural):			
Mining -----do-----	7.4	7.1	- 4.1
Manufacturing -----do-----	1,421.9	1,440.1	+ 1.3
Contract construction -----do-----	211.7	187.6	- 11.4
Transportation and public utilities -----do-----	434.0	427.2	- 1.6
Wholesale and retail trade -----do-----	1,403.8	1,404.2	(¹)
Finance, insurance, real estate -----do-----	577.3	575.1	- .4
Services -----do-----	1,450.7	1,465.4	+ 1.0
Government -----do-----	1,327.2	1,264.0	- 4.8
Total nonagricultural employment -----do-----	² 6,834.1	6,770.7	- .9
Personal income:			
Total -----millions---	\$118,248	\$126,925	+ 7.3
Per capita -----do-----	\$6,542	\$7,019	+ 7.3
Construction activity:			
Number of private and public residential units authorized -----do-----	30,761	30,476	- .9
Value of nonresidential construction -----millions---	\$626.4	\$636.9	+ 1.7
Value of State road contract awards -----do-----	\$295.0	\$500.0	+ 69.5
Shipments of portland and masonry cement to and within New York -----thousand short tons---	2,663	2,245	- 15.7
Mineral production value:			
Total crude mineral value -----millions---	\$397.7	\$428.0	+ 7.6
Value per capita, resident population -----do-----	\$22	\$24	+ 9.1
Value per square mile -----do-----	\$8,023	\$8,632	+ 7.6

^p Preliminary.¹ Increased less than 0.05%.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.

Employment.—Total employment in New York in August 1976 was 7,036,500. Total unemployment in the same period was 777,700, a rate of 9.4%. A comparison of total nonagricultural employment in the State, in thousands, by various sectors is as follows:

	1976	
	Janu- ary	Decem- ber
Manufacturing -----	1,399.2	1,441.7
Durable goods -----	688.9	714.7
Stone, clay, glass ---	35.8	37.6
Primary metals ---	56.2	58.6
Other durables -----	596.9	618.6
Non-durable goods -----	710.3	727.0
Chemicals -----	73.1	74.6
Rubber and plastic products -----	27.2	28.9
Other non-durables ---	610.0	628.5
Mining -----	6.3	7.0
Other industries and services -----	5,263.4	5,359.9
Total employment ---	6,669.0	6,808.5

Source: New York State Department of Labor.

Legislation and Government Programs.—In 1976 the State's mined land

reclamation law, which took effect in 1975, was amended by chapters 476, 477, and 774 of the laws of 1976. The legislature declared the policy of the mined land reclamation law was to foster and encourage the development of the mining industry and the mineral resources of the State, to prevent pollution, and to assure reclamation of mined lands in such manner as to render such lands suitable for productive use.

In response to the mandate of the 1975-76 legislative session, the Department of Environmental Conservation prepared an environmental assessment relative to development of natural gas reserves beneath the New York portion of Lake Erie. This report was expected to be released to the public early in 1977.

The U.S. Geological Survey reported finding concentrations of titanium-bearing sands on a 30-square-mile section of Lewis and Oneida Counties in the Port Leyden area.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasives, Manufactured.—The Carborundum Co., Electro Minerals Div., and the General Abrasives Co., a division of U.S. Industries, Inc., in Niagara County, operated electric furnaces for producing fused aluminum oxide and silicon carbide. The finished products were used in abrasives and in refractories and other nonabrasives.

Metallic abrasives consisting of cut wire, shot grit, and steel shot, were produced by Cleveland Metal Abrasive Co., a division of Fanner Manufacturing Co., and Pellets, Inc., in Erie County.

Calcium Chloride.—Allied Chemical Corp. produced synthetic calcium chloride at Onondaga as a byproduct of the manufacture of soda ash. Output increased 5% above that of the previous year.

Cement.—Shipments of all types of cement increased 1% in quantity and 6% in value above those of 1975. Cement continued to rank first in value among the State's mineral industries. Portland cement accounted for 98% of the cement value. Shipments of masonry cement decreased 9% in quantity. Two plants closed down during the year; namely, the Universal Atlas Cement plant at Hudson, and the Penn Dixie Cement Corp. plant at Howes Cave. Slowdown in building construction was given as the major cause for closing. Four plants produced portland cement exclusively, and four plants produced portland and masonry cement. Six plants were in operation at the end of the year. Cement production was from six counties: Albany, Columbia, Greene, Onondaga, Schoharie, and Warren.

Clays.—Clay production decreased 21% in quantity but increased 34% in value. The average value of clays produced was \$3.22 per ton. Shale and common clay were mined in Albany, Broome, Columbia, Erie, Nassau, Onondaga, Schoharie, and Ulster Counties. Ball clay was produced only in Albany County by Industrial Mineral Products, Inc. Clay was used for portland cement, brick, lightweight aggregate, pottery, and abrasive bonding.

Emery.—The entire U.S. production of emery was recovered from two open pit mines in Westchester County. Quantity of

production decreased 12%, and value decreased 79% from that of 1975. Production was used for general abrasive purposes and for use as an aggregate for heavy-duty, non-slip floors.

Garnet.—The output of abrasive garnet increased 76% in quantity and 85% in value over that of 1975. The open pit garnet mine, operated by Barton Mines Corp., in Warren County, sold garnet for precision uses in coated abrasives, glass grinding and polishing, and metal lapping. Garnet was also recovered as a byproduct of wollastonite mining by Interpace Corp., in Essex County, and was sold for sandblasting and for general abrasive purposes.

Gem Stones.—The collection of gem stones and mineral specimens was principally done by amateurs. The value of gem stone production was estimated to be about \$15,000.

Graphite, Manufactured.—Graphite manufactured from petroleum coke and other materials was produced by Great Lakes Carbon Corp., Aircro Speer Electronics, Carborundum Metals Co., and Union Carbide Corp. The principal uses were for shapes: Anodes, electrodes, electric motor brushes, crucibles, and other refractories. Synthetic graphite powder was used in steelmaking, an additive in non-ferrous metallurgy, foundry facings, and in lubricants.

Gypsum.—Output of crude gypsum increased 13%. Closure of National Gypsum Co.'s operations in Erie County reduced the number of producers to one: United States Gypsum Co. in Genesee County.

Gypsum was calcined at company-owned plants for use in manufacturing building materials. Six calcining plants located in Bronx, Erie, Genesee, Richmond, Rockland, and Westchester Counties were in operation. Output increased 3% to 740,000 tons.

Uses for the calcined gypsum were in the manufacture of wallboard and lath, and in the formulation of various types of plasters. Other uses were in the manufacturing of pottery, glass, industrial molding, and art. Some crude gypsum was used as a retarder in portland cement.

The Public Service Commission approved construction of 10 miles of natural gas pipeline through Genesee and Wyoming Coun-

ties to the United States Gypsum Co. board plant at Oakfield in Genesee County. The company controls oil and gas leases covering about 25,000 acres within 10 miles of the plant.

Lime.—Bethlehem Steel Corp. and Allied Chemical Corp. produced quicklime in Erie and Onondaga Counties for use in alkalis and the basic oxygen furnace (BOF) steel process. Output increased 17% in quantity and 45% in value above that of the previous year.

Nitrogen Compounds.—Atmospheric nitrogen recovered by two companies at Niagara Falls was used to prepare anhydrous ammonia which was used in chemical applications, fertilizers, and other industrial applications.

Peat.—Sales of peat in 1976 were 32,000 short tons, valued at \$684,000. Peat was used mainly for horticultural use. Orange County was the leading producing area; output was also reported from Westchester and Seneca Counties.

Perlite.—Crude perlite mined in Western States was expanded at plants operated by National Gypsum Co., in Bronx and Erie Counties; Georgia-Pacific Corp. and Buffalo Perlite Co., in Erie County; and United States Gypsum Co., in Genesee and Richmond Counties. Scolite International Corp. operated a plant in Rensselaer County. Output of expanded perlite increased 28% in quantity and 32% in value over that of 1975. The most important use was in lightweight acoustical building plaster. Other uses included loose fill insulation, soil conditioning, and filtration.

Salt.—The output of salt increased 9% in quantity and 16% in value over that of 1975; the overall value per ton increased 7%. Most evaporated salt produced was used in food processing and seasoning. Another large use was in manufacturing chlorine and other chemicals. The principal

Table 4.—New York: Salt sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1972 -----	5,604	43,866
1973 -----	5,202	42,364
1974 -----	6,464	57,705
1975 -----	5,978	57,844
1976 -----	6,495	66,441

use for rock salt was for ice control on highways. Other important uses for rock salt were in the chemical and food industries. Brine was used for the manufacture of soda ash, chlorine, and other chemicals. Salt for chemical manufacture was consumed within the State.

Rock salt was produced from one mine each in Livingston, Tompkins, and Yates Counties. Early in 1976, Morton-Norwich Co. closed its Lake Seneca rock salt mine located in Yates County. The reduced demand for road salt in the Northeastern United States was cited as the reason for closing. Evaporated salt was produced from two operations in Schuyler County, and from one operation in Wyoming County.

Sand and Gravel.—Production of sand and gravel increased 26% in quantity and 27% in value over that of 1975. The average value of construction sand and gravel was \$2.00 per ton. The 471 operating mines produced 27.9 million tons of sand and gravel valued at \$56.1 million. Bank run (unprocessed) sand and gravel amounted to 24% of the total output. Two operations produced over 1 million tons, and six had production between 500,000 and 1 million tons. Production from the eight largest producers in the State represented 25% of the total commercial output. More than 2 million tons of production was reported from the following counties: Cattaraugus, Dutchess, Nassau, and Suffolk.

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

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	16,025	\$29,875	\$1.86
Gravel	11,700	25,449	2.18
Total	27,725	¹ 55,326	2.00
Industrial:			
Sand	184	755	5.63
Gravel	22	51	2.32
Total	156	806	5.17
Grand total	27,881	56,132	2.01

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

Table 6.—New York: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	9,097	\$24,459	\$2.69
Concrete products (cement blocks, bricks, pipe, etc.)	1,958	4,657	2.38
Asphaltic concrete aggregates and other bitumi- nous mixtures	3,465	8,652	2.50
Roadbase and coverings	6,167	9,153	1.48
Fill	5,196	6,285	1.21
Other uses	1,842	2,118	1.15
Total	27,725	¹ 55,326	2.00

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

Stone.—Total stone production decreased 11% in quantity and 7% in value from that of 1975. Stone was the second most valuable mineral commodity produced in the State. Crushed and broken limestone, and dolomite, considered together as carbonate rock, accounted for 90% of the tonnage and 85% of the value of all stone produced. Among the States, New York ranked third in output of dimension sandstone; and fourth in dimension and crushed slate.

The chief uses of crushed limestone were for the manufacture of cement, lime, and as a construction aggregate. Other uses

were agricultural stone, railroad ballast, fluxing stone, and asphalt filler.

Basalt (traprock) ranked second in quantity of stone produced. The chief uses were for road metal and concrete aggregate.

Sandstone and slate were quarried as dimension stone and as crushed stone. The chief uses of dimension stone were for flagging, curbing, and architectural applications. Crushed sandstone was used for concrete aggregate and roadstone. Granite was quarried and dressed mostly for building stone. Crushed granite was used for concrete aggregate, railroad ballast, and road metal.

Table 7.—New York: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	7,098	19,910	5,966	17,380
Roadstone -----	5,241	13,161	4,986	12,930
Dense-graded roadbase stone -----	5,791	13,420	4,696	12,350
Cement manufacture -----	5,409	8,944	4,643	6,973
Concrete aggregate -----	3,390	8,641	2,884	7,779
Surface treatment aggregate -----	1,488	4,066	1,390	4,122
Riprap and jetty stone -----	749	2,149	983	3,102
Macadam aggregate -----	457	1,126	408	1,006
Fill -----	264	729	316	890
Agricultural limestone -----	306	1,491	258	1,358
Railroad ballast -----	175	397	256	602
Bedding material -----	20	W	20	33
Terrazzo and exposed aggregate -----	W	W	10	139
Lightweight aggregate -----	9	58	W	W
Other uses ² -----	1,282	4,657	1,290	4,157
Total³ -----	31,680	78,750	23,110	72,830

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

¹ Includes limestone, traprock, sandstone, slate, and granite.

² Includes stone used as chemical stone, other fillers, lightweight aggregate, asphalt filler, drain fields, whitening, lime manufacture (1975), abrasives, flux stone, and uses indicated by symbol W.

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

Table 8.—New York: Production of dimension stone,¹ by use

Use	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Rough flagging -----	7,675	\$771	9,434	\$825
Dressed flagging -----	6,495	327	7,002	352
Cut stone -----	3,596	600	4,883	671
Rubble -----	2,227	36	2,207	38
House stone veneer -----	3,528	131	1,068	34
Irregular-shaped stone -----	8,863	29	889	22
Flooring -----	795	181	887	184
Structural and sanitary purposes -----	145	16	W	W
Other uses ² -----	1,200	87	1,122	84
Total³ -----	34,520	2,178	27,490	2,211

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

¹ Includes sandstone, slate, and granite.

² Includes stone used in rough blocks, curbing, construction, electrical (1975), and uses indicated by symbol W.

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

Sulfur.—Ashland Oil, Inc., recovered 4,646 long tons of sulfur at its Buffalo refinery in Erie County in 1976.

Talc.—In 1976 the output of talc increased in both quantity and value, 11% and 6%, respectively. All production was from operations of the Gouverneur Talc Co., Inc., a subsidiary of the R. T. Vanderbilt Co. Crude talc was ground in company-owned mills and used mainly in ceramics and as a filler in paints. Smaller quantities were used as a filler in floor tile, rubber, paper, and other miscellaneous products.

Vermiculite.—Crude vermiculite mined in other states was exfoliated at the Construction Products Div. plant of W. R. Grace & Co. The expanded vermiculite was used for loose fill insulation (49%), concrete aggregate (20%), block insulation (16%), and soil conditioning (15%).

Wollastonite.—The entire U.S. production of wollastonite was mined and beneficiated at the Willsboro mine in Essex County operated by Interpace Corp. Production in 1976 increased 31% and value of shipments increased 49% above the 1975 levels. The refined wollastonite was used

as an ingredient in ceramic products and as a filler in paints and plastics.

METALS

Aluminum.—Production of primary aluminum from the Massena plants of the Aluminum Co. of America (Alcoa) and Reynolds Metals Co., in St. Lawrence County, increased 10% in tonnage and 23% in value over that produced in 1975. Alcoa completed its expansion program at a cost of about \$60 million. Production capacity was raised to 190,000 tons of primary aluminum metal from its previous annual capacity of 135,000 tons.

Iron Ore.—Shipments of iron ore to consumers increased 19% in quantity and 10% in value above that of 1975. The entire production was from two open pits: NL Industries, Inc., Tahawus operation, as a coproduct with ilmenite production and Jones & Laughlin Steel Corp., Star Lake mine, in St. Lawrence County. All of the product was beneficiated and shipped as a

concentrate. Principal uses for the shipments were in the manufacture of pig iron, the manufacture of cement, for heavy media separation in other iron ore plants, and for coal beneficiation.

Lead.—St. Joe Minerals Corp. produced lead as a byproduct of zinc mining at its Balmat and Edwards mines, in St. Lawrence County. The lead concentrate was shipped to the company's lead smelter at Herculaneum, Mo. In 1976 the quantity of lead produced increased 6%, while value increased 13% over that of 1975.

Mercury.—The St. Joe Minerals Corp. recovered mercury as a byproduct from zinc mining at Balmat Edwards, St. Lawrence County. The mercury was recovered at the company's smelter in Monaca, Pa.

Silver.—The quantity of silver recovered from lead concentrates shipped by St. Joe Minerals Corp., in St. Lawrence County, decreased in both quantity and value 12% and 14%, respectively. Silver recovery reflects the demand for silver-free lead, rather than the silver content of the concentrates.

Table 9.—New York: Mine production (recoverable) of silver, lead, and zinc

	1974	1975	1976
Mines producing: Lode	2	2	3
Material sold or treated: Zinc ore	1,232	1,247	1,239
Production:			
Quantity:			
Silver	64,463	56,047	49,199
Lead	3,076	3,027	3,196
Zinc	93,077	76,612	73,671
Value:			
Silver	\$304	\$248	\$214
Lead	1,384	1,302	1,476
Zinc	66,829	59,757	54,517
Total	68,517	¹ 61,306	56,207

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

Titanium Concentrate (Ilmenite).—Ilmenite concentrate was recovered as a coproduct of magnetite from an open-cut titaniferous magnetite deposit near Tahawus, Essex County. Ilmenite concentrate was used principally in the manufacture of titanium dioxide pigment.

Zinc.—New York ranked third in U.S. zinc production. Output decreased in both quantity and value, 4% and 9%, respectively, from that of 1975. The entire production in the State was from the Balmat

and Edwards mines of the St. Joe Minerals Corp., in St. Lawrence County. The Balmat and Edwards complex is the largest single zinc mining operation in the United States.

MINERAL FUELS

Natural Gas.—The production of natural gas in New York in 1976 increased 21% over that of the previous year. The quantity and value of natural gas produced in the State for the period 1972-76 follows:

Year	Quantity ¹ (million cubic feet)	Value (thousand dollars)
1972	3,679	1,199
1973	4,539	1,590
1974	4,990	2,745
1975	7,623	5,645
1976	9,235	10,436

¹ Marketed production of natural gas represents gross withdrawals less gas used for repressuring and quantities vented and flared.

Natural gas was produced in 13 counties; Steuben County was the largest producer, followed by Erie, Chautauqua, Allegany, Cattaraugus, Cayuga, Genesee, Ontario, Madison, Livingston, Seneca, Wyoming, and Monroe Counties. At yearend, there were 1,195 wells producing natural gas. Extensive leasing activity was reported in progress in the Catskill Region, in Orange, Sullivan, and Ulster Counties.

Table 10.—New York: Oil and gas well drilling completion in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Allegany	31	--	10	--	--	5	36	53,305
Cattaraugus	57	3	--	--	4	7	81	132,319
Cayuga	--	4	--	--	2	1	7	16,602
Chautauqua	39	296	18	--	8	--	361	1,028,279
Chemung	--	--	--	--	--	2	2	8,081
Erie	--	14	1	--	2	--	17	36,854
Genesee	--	11	--	--	2	--	13	19,176
Livingston	--	--	--	--	1	--	1	2,608
Oneida	--	--	--	--	--	1	1	729
Onondaga	--	--	--	--	--	3	3	8,035
Ontario	--	1	5	--	1	--	7	11,819
Schuyler	--	--	--	--	--	1	1	2,895
Seneca	--	6	--	--	--	--	6	13,572
Steuben	6	--	1	--	--	10	17	48,143
Wyoming	--	--	--	--	--	2	2	8,653
Total	133	335	35	--	20	32	555	1,391,070

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
The Carborundum Co -----	Box 423 Niagara Falls, N.Y. 14302	Plant -----	Niagara.
General Abrasives Co., a division of U.S. In- dustries, Inc.	2100 College Ave. Niagara Falls, N.Y. 14302	---do -----	Do.
Fanner Manufacturing Co -	Brookside Park Cleveland, Ohio 44109	---do -----	Erie.
Pellets, Inc -----	531 South Niagara St. Tonawanda, N.Y. 14150	---do -----	Do.
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. ¹	15 South 3d St. Easton, Pa. 18043	---do -----	Greene.
The Flintkote Co. ² -----	400 Westchester Ave. White Plains, N.Y. 10604	---do -----	Warren.
Lehigh Portland Cement Co. ²	718 Hamilton St. Allentown, Pa. 18105	---do -----	Greene.
Marquette Cement Manu- facturing Co. ^{1,2}	20 North Wacker Dr. Chicago, Ill. 60606	---do -----	Do.
Newmont Mining Corp. ^{1,2} -	Box 30 Stamford, Conn. 06904	---do -----	Albany.
Clays:			
Lone Star Industries, Inc. ¹ -	1 Greenwich Plaza Greenwich, Conn. 06830	Pits -----	Ulster.
Nassau Brick Co., Inc ----	635 Round Swamp Rd. Long Island, N.Y. 11804	---do -----	Nassau.
Norlite Corp -----	628 South Saratoga St. Cohoes, N.Y. 12047	---do -----	Albany.
Emery:			
De Luca Emery Mine, Inc -	926 Constant Ave. Peekskill, N.Y. 10566	Pit -----	Westchester.
Garnet:			
Barton Mines Corp -----	North Creek, N.Y. 12853 --	Pit -----	Warren.
Gypsum:			
Georgia-Pacific Corp. ³ ----	Box 311 Portland, Oreg. 97207	Underground mine and plant.	Erie and Westchester.
National Gypsum Co. ³ ----	325 Delaware Ave. Buffalo, N.Y. 14202	Plant -----	Bronx.
United States Gypsum Co. ³ -	101 South Wacker Dr. Chicago, Ill. 60606	Underground mine and plant.	Genesee, Richmond, Rockland.
Iron ore:			
Jones & Laughlin Steel Corp.	Star Lake, N.Y. 13690 ----	Pit -----	St. Lawrence.
NL Industries, Inc. ⁴ -----	Tahawus, N.Y. 12879 -----	Pit -----	Essex.
Lime:			
Allied Chemical Corp. ^{1,5} ----	Box 70 Morristown, N.J. 07960	Plant -----	Onondaga.
Bethlehem Steel Corp ----	701 East 3d St. Bethlehem, Pa. 18016	---do -----	Erie.
Peat:			
Anderson Peat Co., Inc --	Pleasant Hill Rd. Wingdale, N.Y. 12594	Bog -----	Dutchess.
Sterling Forest Peat Co., Inc.	Box 608 Tuxedo, N.Y. 10987	Bog -----	Orange.
Petroleum:			
Ashland Oil & Refining Co. ¹	Tonawanda, N.Y. 14150 ----	Refineries -----	Erie.
Mobil Oil Corp -----	Buffalo, N.Y. 14221 -----	---do -----	Do.
Salt:			
Cargill, Inc -----	1620 Northstar Center Minneapolis, Minn. 55402	Underground mine.	Tompkins.
International Salt Co ----	Clarks Summit, Pa. 18411 --	---do -----	Livingston.
Morton Salt Co -----	110 North Wacker Dr. Chicago, Ill. 60606	Well -----	Wyoming.
Watkins Salt Co., Inc ----	Box 150 Watkins Glen, N.Y. 14891	---do -----	Schuyler.
Sand and gravel:			
Albany Gravel Co -----	North Pearl St. & Loudonville Albany, N.Y. 12201	Pit -----	Albany and Rensselaer.
Buffalo Slag Co -----	111 Great Arrow Ave. Buffalo, N.Y. 14216	Plants -----	Allegany, Cattaraugus, Steuben.

See footnotes at end of table.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Colonial Sand & Stone Co., Inc. ^{1,2,6}	1740 Broadway New York, N.Y. 10019	Pit -----	Dutchess and Nassau.
General Crushed Stone Co	712 Drake Bldg. Easton, Pa. 18042	Pit -----	Cattaraugus and Chemung. Suffolk.
Keyway Mason Supply Corp.	25 Montclair Ave. St. James, N.Y. 11780	Pit -----	Do.
Roanoke Marbro Sand & Gravel Corp.	Box 172 Riverhead, Long Island, N.Y. 11901	Pit -----	Do.
Stone:			
The Callanan Road Improvement Co.	South Bethlehem, N.Y. 12161	Quarry -----	Albany and Ulster.
Dolomite Products Co. ⁷ ----	1150 Penfield Rd. Rochester, N.Y. 14625	----do -----	Monroe.
General Crushed Stone Co	712 Drake Bldg. Easton, Pa. 18042	----do -----	Genesee, Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne. Rockland.
Martin-Marietta Corp ----	Box 120 Mercersberg, Pa. 17236	----do -----	Rockland.
Talc:			
Gouverneur Talc Co., Inc --	Gouverneur, N.Y. 13642	---- Underground mine.	St. Lawrence.
Wollastonite:			
Interpace Corp. ⁸ -----	Willsboro, N.Y. 12996	----do -----	Essex.
Zinc:			
St. Joe Minerals Corp. ⁹ ---	250 Park Ave. New York, N.Y. 10017	Mine -----	St. Lawrence.

¹ Also stone.² Also clays.³ Also expanded perlite.⁴ Also ilmenite.⁵ Also salt.⁶ Also cement.⁷ Also sand and gravel.⁸ Also garnet.⁹ Also silver and lead.

The Mineral Industry of North Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Division of Earth Resources, North Carolina Department of Natural and Economic Resources, for collecting information on all minerals except fuels.

By Lawrence E. Shirley¹ and Eldon P. Allen²

North Carolina's mineral production value for 1976 exceeded \$200 million for the first time, and established a new all-time high. Total mineral production value was \$203.3 million compared with \$153.3 million in 1975, an increase of 33%.

The State again led the Nation in the production of feldspar, lithium minerals, scrap and flake mica, and olivine and was the only pyrophyllite-producing State in the United States. In addition, North Carolina ranked third in the Nation in common clay and shale output, exceeded only by Texas and Ohio. Brick production from the clay and shale established a new record high, totaling 967.2 million brick valued at \$67.7 million. The State ranked second in output of crushed granite, third in crushed marble and crushed miscellaneous stone, and fifth in dimension slate.

Stone was the leading mineral commodity produced. Total stone production was 30.9 million tons valued at \$82.5 million, and accounted for 41% of the State's total mineral production value. The five leading mineral commodities in the State, consisting of stone, phosphate rock, sand and gravel, lithium minerals, and cement, were responsible for 89% of the total mineral production value in 1976.

Leading mineral-producing companies in the State, based on the value of mineral production and listed alphabetically,

were Ideal Basic Industries, Inc. (cement), Martin Marietta Corp., Southeast Div. (crushed stone), Nello L. Teer Co. (crushed stone), Texasgulf, Inc. (phosphate rock), and Vulcan Materials Co. (crushed stone).

Legislation and Government Programs.—The Geology and Mineral Resource Section of the Division of Earth Resources continued its active participation in investigations of various mineral resource and geologic studies. A new directory of North Carolina mineral producers³ was published. The directory lists mineral producers by commodity, region, and product, and should be useful to persons interested not only in mineral resources, but in processed products of the mineral industry. A useful map showing active mining operations in North Carolina as of January 1976 is included.

An important study of metallic mineral deposits in the State was completed and made available during 1976.⁴ The re-

¹ State Liaison Officer, Bureau of Mines, Raleigh, N.C.

² Chief, Geology and Mineral Resources Section, Division of Earth Resources, North Carolina Department of Natural and Economic Resources.

³ McDaniel, R. D., and B. J. McKenzie. Directory of North Carolina Mineral Producers. N.C. Dept. of Nat. and Econ. Res., Div. Earth Res., Min. Res. Sec., 1976, 64 pp., 1 map.

⁴ Carpenter, P. A., III. Metallic Mineral Deposits of the Carolina Slate Belt, North Carolina. N.C. Dept. of Nat. and Econ. Res., Div. Res. Plan. and Eval., Min. Res. Sec., Bull. 84, 1976, 166 pp., 11 plates.

Table 1.—Mineral production in North Carolina¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ² ----- thousand short tons--	2,582	\$4,094	2,750	\$4,677
Feldspar ----- short tons--	r 468,401	r 7,905	515,477	11,549
Gem stones -----	NA	50	NA	75
Mica, scrap ----- thousand short tons--	75	3,265	70	3,793
Mica, sheet ----- pounds	5,000	3	5,000	3
Sand and gravel ----- thousand short tons--	8,169	15,610	9,049	18,287
Stone ----- do	23,308	69,327	30,877	82,462
Talc and pyrophyllite ----- short tons--	r 95,575	r 1,605	113,754	1,087
Value of items that cannot be disclosed:				
Asbestos, cement, clays (kaolin), lithium compounds, olivine, and phosphate rock --	XX	51,477	XX	81,407
Total -----	XX	r 158,336	XX	203,340
Total 1967 constant dollars -----	XX	60,675	XX	p 73,100

^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; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in North Carolina, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Alamance -----	W	W	Stone, clays, talc.
Anson -----	W	W	Sand and gravel, stone.
Ashe -----	W	W	Stone.
Avery -----	\$3,052	W	Mica, sand and gravel, olivine, stone.
Beaufort -----	W	W	Phosphate rock, sand and gravel.
Bertie -----	164	\$227	Sand and gravel.
Bladen -----	W	W	Do.
Brunswick -----	W	W	Sand and gravel, stone.
Buncombe -----	W	W	Stone, sand and gravel, clays.
Burke -----	W	W	Stone, sand and gravel.
Cabarrus -----	W	W	Stone, sand and gravel, clays.
Caldwell -----	W	W	Stone, sand and gravel.
Camden -----	W	W	Sand and gravel.
Caswell -----	W	W	Stone.
Catawba -----	W	W	Stone, sand and gravel.
Chatham -----	W	879	Clays.
Cherokee -----	W	W	Talc, stone.
Chowan -----	1	1	Sand and gravel.
Cleveland -----	12,501	11,112	Lithium minerals, mica, stone, feldspar, sand and gravel, clays.
Craven -----	W	W	Stone, sand and gravel.
Cumberland -----	696	878	Sand and gravel.
Currituck -----	W	W	Do.
Davidson -----	W	W	Stone, clays, sand and gravel.
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	Do.
Franklin -----	126	151	Sand and gravel.
Gaston -----	11,340	11,860	Lithium minerals, stone, feldspar, sand and gravel.
Granville -----	W	W	Talc.
Greene -----	W	W	Sand and gravel.
Guilford -----	4,991	5,783	Stone, sand and gravel, clays.
Halifax -----	W	W	Clays.
Harnett -----	W	W	Sand and gravel, clays.
Haywood -----	W	W	Stone.
Henderson -----	W	W	Stone, clays.
Hertford -----	W	W	Sand and gravel.
Hyde -----	2	1	Do.
Iredell -----	W	W	Stone, clays, sand and gravel.
Jackson -----	W	W	Stone.
Johnston -----	W	W	Stone, sand and gravel.
Jones -----	317	W	Do.
Lee -----	W	W	Stone, clays, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in North Carolina, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Lenoir	W	W	Sand and gravel.
McDowell	\$524	\$615	Do.
Macon	W	W	Stone, sand and gravel.
Martin	8	16	Sand and gravel.
Mecklenburg	W	W	Stone.
Mitchell	^r 6,427	10,327	Feldspar, mica, clays, stone, sand and gravel.
Montgomery	283	1,010	Stone, sand and gravel, clays.
Moore	W	W	Sand and gravel, talc, stone, clays.
Nash	W	--	
New Hanover	14,179	17,939	Cement, stone, clays, sand and gravel.
Northampton	37	W	Sand and gravel.
Onslow	W	W	Stone, sand and gravel.
Orange	W	1,161	Stone, talc, sand and gravel, mica.
Pasquotank	41	W	Sand and gravel.
Pitt	W	W	Stone, sand and gravel.
Polk	W	W	Stone.
Randolph	W	W	Do.
Richmond	W	2,824	Sand and gravel, stone.
Robeson	18	16	Sand and gravel.
Rockingham	W	W	Stone, clays, sand and gravel.
Rowan	W	W	Do.
Rutherford	W	W	Stone.
Sampson	W	W	Clays, sand and gravel.
Scotland	W	W	Sand and gravel.
Stanly	373	490	Clays.
Stokes	W	W	Stone, sand and gravel, clays.
Surry	W	W	Stone, sand and gravel.
Swain	W	W	Do.
Transylvania	W	W	Do.
Union	W	W	Stone, clays.
Vance	W	W	Stone.
Wake	4,278	4,423	Stone, sand and gravel.
Washington	13	16	Sand and gravel.
Watauga	523	486	Stone.
Wayne	222	253	Sand and gravel.
Wilkes	W	W	Stone, sand and gravel.
Wilson	W	W	Do.
Yadkin	W	W	Sand and gravel.
Yancey	1,963	2,111	Olivine, mica, sand and gravel, asbestos.
Undistributed ²	^r 91,254	130,750	
Total ³	^r 153,336	203,340	

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

¹ The following counties are not listed because no production was reported: Alexander, Alleghany, Carteret, Clay, Columbus, Dare, Gates, Graham, Hoke, Lincoln, Madison, Pamlico, Pender, Perquimans, Person, Tyrrell, and Warren.

² Includes gemstones and mica 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

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	2,511	2,556	+1.8
Unemployment ----- do-----	217	159	-26.7
Employment (nonagricultural):			
Mining ----- do-----	4.2	4.6	+9.5
Manufacturing ----- do-----	714.2	757.6	+6.1
Contract construction ----- do-----	105.9	104.0	-1.8
Transportation and public utilities ----- do-----	98.3	96.5	-1.8
Wholesale and retail trade ----- do-----	377.8	396.2	+4.9
Finance, insurance, real estate ----- do-----	82.3	82.1	-.2
Services ----- do-----	267.6	280.8	+4.9
Government ----- do-----	315.8	325.0	+2.9
Total nonagricultural employment ----- do-----	1,966.1	2,046.8	+4.1
Personal income:			
Total ----- millions--	\$26,796	\$29,821	+11.3
Per capita ----- do-----	\$4,925	\$5,453	+10.7
Construction activity:			
Number of private and public residential units authorized -----	20,893	26,030	+24.6
Value of nonresidential construction ----- millions--	\$238.6	\$312.7	+31.1
Value of State road contract awards ----- do-----	\$171.8	\$250.0	+45.5
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,551	1,679	+8.2
Mineral production value:			
Total crude mineral value ----- millions--	^r \$153.3	\$203.3	+32.6
Value per capita, resident population ----- do-----	\$28	\$37	+32.1
Value per square mile ----- do-----	\$2,916	\$3,867	+32.6

^p Preliminary. ^r Revised.

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

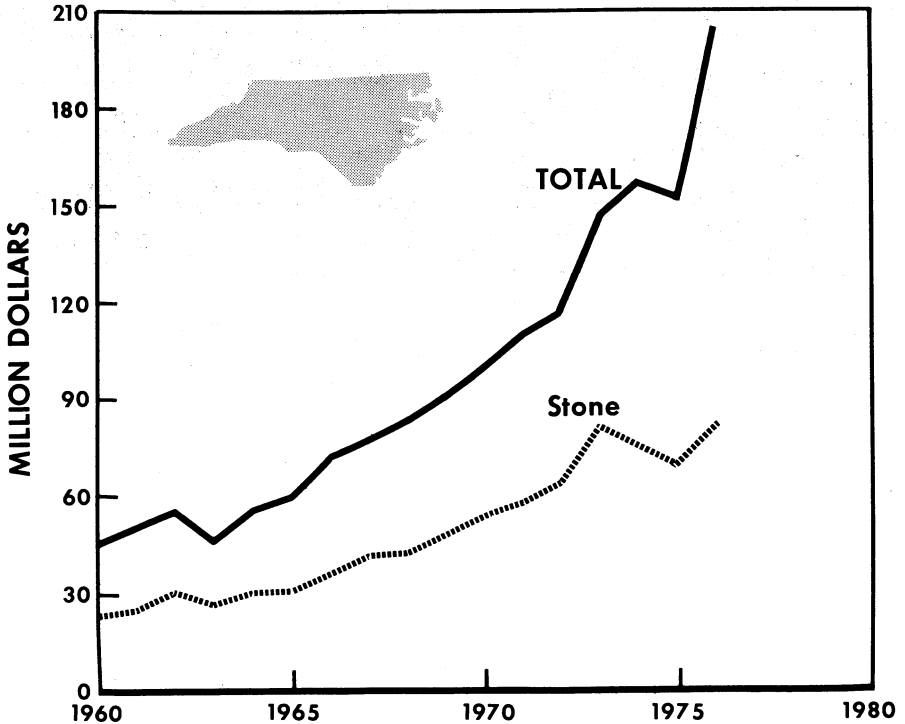


Figure 1.—Value of stone and total value of mineral production in North Carolina.

port is a compilation of information on 195 inactive mines and prospects in the slate belt of the State and covers deposits of metallic minerals, including chromite, copper, gold, iron, lead, zinc, silver, molybdenum, and tungsten. The report is illustrated with tables and figures on the various deposits, and county maps show the location of each mine or deposit.

The State's geology and mineral resources were discussed in a report⁵ prepared to present students and others with a broad perspective of the geology of the State. Particular emphasis was placed on important economic mineral commodities, major rock-forming minerals, and the various rock groups and types that are found throughout the State.

A fourth publication comprises an index of geologic and geophysical mapping and reconnaissance and groundwater investigations.⁶ The report includes a map delineating areas of geologic mapping in North Carolina, and lists State publications and Federal publications covering these areas. A similar map showing geophysical mapping in the State, with a list of publications, is also included; a groundwater index map with groundwater publications completes the report.

State Government reorganization during the year affected several of the groups concerned primarily with mineral resources and mining within the State. The Division of Resource Planning and Evaluation of the North Carolina Department of Natural and Economic Resources was re-

named the Division of Earth Resources. The Mineral Resource Section of the Division of Earth Resources was renamed the Geology and Mineral Resources Section. The Land Quality Section, which was formerly a part of the Division of Environmental Management, was removed from that Division and placed under the Division of Earth Resources. The Mine Restoration group within the Land Quality Section has the responsibility for permitting all mining operations in the State and for enforcement of the North Carolina Mining Act of 1971.

On February 1, 1976, the North Carolina Mining Commission filed with the Attorney General, Subchapter 5B—Mining Permitting Regulations, which amends and expands Mining Permitting Regulations as described under G.S. 74-50 of the Mining Act of 1971. This action covers procedures for obtaining permits, information required, standards for denying an application, modification and renewal of permits, and standards for revoking a permit.

At the end of the fiscal year, the Mine Restoration group had conducted 750 mine inspections, had 482 mining operations under permit, and had total bonded acreage of 10,365. Total acres disturbed during the year was 965 and total acres reclaimed at active mines was 881. The following tabulation shows number of active mines and acreage information for major commodities:

Commodity	Number of mines	Annual acres disturbed	Acres reclaimed
Sand and gravel -----	250	459	379
Crushed stone -----	102	203	83
Industrial minerals -----	44	204	367
Clay and shale -----	46	86	33
Dimension stone -----	19	2	--
Gem stones -----	21	11	19

Minerals research in North Carolina was conducted primarily by the Asheville Minerals Research Laboratory of the North Carolina State University. During 1976, the laboratory completed several sponsored and unsponsored studies on a wide variety of minerals within the State, as well as on out-of-State and foreign minerals. Unsponsored research projects included those on magnetic beneficiation of

phosphate and evaluation of gold ore. Sponsored projects included those on coal

⁵ Wilson, W. P., P. A. Carpenter, III, and S. G. Conrad. North Carolina Geology and Mineral Resources: A Foundation for Progress. N.C. Dept. of Nat. and Econ. Res., Div. Res. Sec., Educational Series No. 4, 1976, 78 pp.

⁶ Carpenter, P. A., III. Index of Geologic and Geophysical Mapping and Reconnaissance and Groundwater Investigations in North Carolina. N.C. Dept. of Nat. and Econ. Res., Div. Res. Plan. and Eval., Min. Res. Sec., 1976, 7 pp.

flotation; removal of tremolite from vermiculite; flotation of glass sand from an Idaho deposit; beneficiation of phosphate from Colombia, South America; evaluation of olivine ore samples and gravity concentration of olivine; several studies on flotation and beneficiation of phosphate, feldspar, and garnet; and projects involving the sizing and upgrading of mica. Research continued on the evaluation of glass sands; completed studies have contributed to the growth of the glass industry in the State.

Progress was made during 1976 on North Carolina's Coastal Area Management Act (CAMA), which was passed by the 1974 General Assembly. CAMA required that State and local governments work together to plan land use in North Carolina's coastal area. All 20 coastal counties and 33 municipalities located in those counties elected to develop land use plans under the program. Most of the work on these plans was done in 1975 and 1976. In February 1976, the Coastal Resources Commission (CRC) began work on the Interim Areas of Environmental Concern (IAEC) and the program became effective in August 1976. Final land use plans were received for review and approval from 51 of the 53 localities in May 1976. These plans were reviewed by the State Government review team and by a number of Federal agencies during late May and early June. All 51 plans were judged to be acceptable and were approved on June 30, 1976. The remainder of the year was spent in development of a model local implementation plan and necessary ordinances for the Areas of Environmental Concern.

Trends and Developments.—North Carolina experienced a very successful industrial development year in 1976. There were indications in the first 6 months of the year that the economic recession experienced in 1975 was abating. During the year, according to the Division of Economic Development of the North Carolina Department of Natural and Economic Resources, total capital investment in new and expanding industry in the State in 1976 was in excess of \$1 billion. This total investment was in 124 new plants and 911 expansions of existing plants. The expansions resulted in 11,573 jobs being created;

total number of jobs created by both new and expanding industry was 19,666.

In the area of international trade and commerce, North Carolina continued to make impressive strides. In June 1976, the Governor of North Carolina led a group of State officials and businessmen on a trade mission to the Far East, which led to new industrial prospects for future location in the State. Since June, more than 100 businessmen from 12 foreign countries representing 50 different companies have visited North Carolina. Foreign investments in 1976 totaled more than \$30 million.

Electric power in North Carolina is provided principally by Carolina Power and Light Co. (CP&L), Duke Power Co., and Virginia Electric and Power Co. (Vepco). According to the 1976 Annual Report of CP&L, at yearend the company was providing electric service to about 677,000 customers in an area of about 30,000 square miles—almost half of North Carolina and about one-fourth of South Carolina. During the year, the company generated 68% of its energy from coal; 27%, from nuclear fuel; and the remaining 5%, from hydroelectric sources, oil, and natural gas. Construction and expenditures during 1976 totaled \$206 million. Nuclear fuel expenditures during 1976 totaled \$21.4 million. At yearend, CP&L had invested \$709 million in its Brunswick nuclear plant near Wilmington; the plant includes an earlier unit (No. 2), which began commercial operation in 1975; unit No. 1 is expected to go into operation in April 1977. Total investment in the completed plant, including the expense for cooling towers and other modifications to the cooling system, will be approximately \$824 million.

According to Duke Power Co.'s 1976 annual report, the company sold 45.6 billion kilowatt-hours of electricity during 1976, an 8.3% increase over the amount sold in 1975. Of the total kilowatt hours generated in 1976, 70.6% came from coal-fired units; 25.5%, from nuclear units; and 3.9%, from hydroelectric and other sources. Duke's steam-fossil generating system set a new company record for thermal efficiency in 1976. The year's heat rate of 9,315 Btu of energy per net kilowatt-hour was the lowest ever reported to the Fed-

eral Power Commission for a multiplant generating system. Completion dates of eight major generating units in the Duke system were pushed back in 1976 as a result of reduced load forecasts, design changes, and delays in receiving components from manufacturers. Most of the delayed units were at the company's nuclear stations. In 1970, Duke Power Co. organized the Eastover Mining Co. and the Eastover Land Co. to help assure an adequate supply of coal for Duke's coal-fired generating plants. At yearend, Eastover owned or had controlling interest in approximately 30,600 acres of coal reserves in eastern Kentucky and Virginia, with an estimated 245 million tons of recoverable coal. Eastover mines provided approximately 17% of Duke's coal requirements in 1976 and 15% in 1975.

Veeco continued to service a small area in the northeastern part of North Carolina. According to Veeco's 1976 annual report, total capital expenditures throughout the company's service area (three states) were \$481.6 million, of which 66% was for new generating facilities. In 1976, the company spent about \$4 million in support of research and development, including \$2.9 million to the Electric Power Research Institute (EPRI), about \$0.5 million of which was directed toward a fast-breeder reactor program. The company spent about \$60 million on measures to protect the environment; a substantial portion of these funds was spent on the North Anna nuclear project. In addition, Veeco upgraded the electrostatic precipitators on the Chesterfield plant, which had been converted from oil to coal, and initiated construction of waste treatment facilities at various generating stations.

Employment and Injuries.—According to the Annual Report for 1976 on Administration of the Federal Metal and Non-metallic Mine Safety Act (Public Law 89-577), North Carolina had 373 mines and mills active throughout the year. The Mining Enforcement and Safety Administration (MESA) conducted 420 regular inspections and 384 spot inspections at the 373 mines and mills in 1976. Notices issued as a result of these inspections totaled 1,452 and notices abated were 1,659. Orders issued were 21 and orders abated were 19. Preliminary data indicated 2 fatalities and a total of 79 disabling injuries were reported at both surface mines and mills; 50 injuries were at surface mines and the remaining 29 at mills. The disabling-injury frequency rate at surface mines was 8.70 and at mills was 10.67.

On October 27, 1976, North Carolina became the eighth State to sign a State Plan agreement with the Department of the Interior as provided by Section 16 of the Federal Metal and Nonmetallic Mine Safety Act, P. L. 89-577. Under the terms of the agreement, MESA retains authority to inspect mines in a State Plan State and to issue orders for imminent danger, but relinquishes its authority to issue notices of violations of Federal mandatory standards. The role of MESA, therefore, is primarily one of monitoring the effectiveness of the State agency's enforcement program and is carried out through combined Federal and State inspections, reports submitted by the State, and Federal inspections and investigations as necessary. MESA continued to maintain a field office in Salisbury, for the purpose of monitoring the State agency's enforcement program and to conduct inspections when necessary.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Powhatan Mining Co. produced amphibole asbestos from its Hippy mine in Yancey County. Output and value increased substantially over that of 1975.

Cement.—Ideal Basic Industries, Inc., the only cement-producing company in the State, continued output of masonry and portland cement at its Castle Hayne

plant in New Hanover County. According to Ideal's 1976 annual report, the annual capacity of the Castle Hayne plant remained at 610,000 tons. Other Ideal cement facilities in the State comprised a terminal at Wilmington and sales office at Raleigh.

Clays.—Twenty-seven companies with 47 mines in 23 counties produced common clay and shale, and kaolin. Total output of

clay and shale was 2.8 million tons valued at \$4.7 million, compared with 2.6 million tons valued at \$4.1 in 1975. Most of the common clay and shale output was used in the manufacture of face and common brick, sewer pipe, concrete block, structural concrete, and cement. The Brick Association of North Carolina, Greensboro, which represents most of the brick manufacturers in the State, reported a significant surge in total brick produced in 1976 to 967.2 million brick valued at \$67.7 million. Continuing improvement in technology and automation in this highly competitive industry was primarily responsible

for this increased production as cited by the Brick Association.

Leading producers of common clay and shale, listed in order of output, were Sanford Brick Corp. (three mines), Solite Corp., Div. of Virginia Solite Corp., (two mines), Boren Clay Products Co. (four mines), and Pine Hall Brick & Pipe Co. (four mines).

Kaolin was produced by only two companies, Harris Mining Co. and Kings Mountain Silica Co. The kaolin was both processed and unprocessed and was used by the speciality china and refractory industries and for face brick.

Table 4.—North Carolina: Common clay and shale sold or used by producers, by county

County	1975			1976		
	Number of mines	Quantity (short tons)	Value	Number of mines	Quantity (short tons)	Value
Alamance -----	2	61,049	\$79,400	1	W	W
Buncombe -----	1	36,000	48,600	1	36,000	\$52,200
Cabarrus and Durham -----	4	226,436	396,403	4	265,775	415,213
Chatham -----	4	452,649	802,993	4	442,277	879,489
Cumberland -----	1	W	W	1	W	W
Davidson -----	1	80,000	96,000	1	80,000	104,000
Guilford -----	3	66,075	89,300	3	71,331	103,500
Harnett -----	4	40,180	56,560	2	35,200	53,478
Henderson -----	1	54,000	72,900	1	54,000	73,300
Iredell -----	1	26,897	35,000	1	23,398	33,900
Lee -----	4	333,750	489,850	4	414,895	623,720
Montgomery and New Hanover -----	4	166,405	404,125	4	139,544	300,454
Rockingham -----	5	435,621	514,921	5	375,505	491,000
Rowan -----	4	126,845	167,900	4	162,722	232,800
Sampson -----	1	28,544	35,600	1	58,642	85,000
Stanly -----	3	237,320	372,700	3	279,370	489,900
Stokes -----	1	14,255	14,255	1	25,418	25,000
Union -----	1	128,575	321,500	1	165,926	497,800
Undistributed ¹ -----	2	67,359	92,640	4	120,008	169,500
Total -----	47	2,581,960	4,093,650	45	2,750,011	4,677,254

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

¹ Includes Halifax and Moore Counties, and data indicated by symbol W.

Feldspar.—North Carolina again led the Nation in the production of feldspar. Feldspar was produced by six companies from eight mines in Cleveland, Gaston, and Mitchell Counties, with most of the production coming from five mines in Mitchell County. Total output was 515,477 tons valued at \$11.5 million. Leading producers, listed in order of output, were The Feldspar Corp., Lawson-United Feldspar and Mineral Co., and Sobin Chemicals, Inc., all with operations in Mitchell County. Production was principally in the form of flotation concentrates and feldspar-silica mixtures.

Ground feldspar, for use principally by the glass industry and for pottery and other uses, was produced by four companies with three plants in Mitchell County and one plant in Cleveland County. Total output of ground feldspar was 468,000 short tons valued at \$10.2 million. Most of the material was shipped out-of-State or supplied to other grinding operations.

Gem Stones.—Amateur collectors and rockhounds were active in the gem- and mineral-collecting areas of the State, particularly in the Franklin area of Macon County, the Spruce Pine area in Mitchell

County, and near Hiddenite in Alexander County.

Graphite.—Synthetic graphite products, including anodes, electrodes, crucibles, and vessels, and graphite specialties were produced by Great Lakes Carbon Corp. at its plant near Morganton. Raw material used is coal tar pitch obtained from out-of-State sources.

Gypsum.—Texasgulf, Inc., marketed by-product gypsum recovered from the manufacture of phosphoric acid at its Lee Creek processing operation near Aurora. Reportedly, the gypsum was sold to peanut farmers within a 200-mile radius as a source of calcium for growing peanuts. The company also used the gypsum mixed with clay and other soils as landfill.

Iodine.—Mallinkrodt Chemical Works, near Raleigh, Wake County, consumed crude iodine in the manufacture of several products. The company operated three plants in the Raleigh area producing high purity specialty chemicals, plastics, and other products.

Lithium Minerals.—North Carolina again led the Nation in the production of lithium minerals. Two companies produced spodumene from pegmatites in the Kings Mountain and Bessemer City areas and processed the material at nearby plants. Foote Mineral Co., longtime lithium minerals producer in the State, continued to mine spodumene and produce lithium carbonate at Kings Mountain. According to Foote's 1976 annual report, the company's new lithium carbonate plant, started up in December; the plant was designed to increase Foote's output of lithium carbonate by 12 million pounds annually. Foote also completed major modifications in the fourth quarter of 1976 at its lithium hydroxide plant at Sunbright, Va., which permits the use of lithium carbonate instead of spodumene concentrates as the raw material for the plant. Foote reported at yearend a significant increase in the sale of lithium carbonate for use by the aluminum industry as a potline additive. Other major users of lithium carbonate were the ceramics and glass industries. Interest in lithium for battery applications continued at a high level during the year, although battery-related sales had no significant impact on the company's sales or earnings in 1976.

Lithium Corp. of America, Inc. (Lithcoa), a wholly owned subsidiary of Gulf Resources and Chemical Corp., produced spodumene from pegmatite deposits in the Bessemer City area and shipped concentrates to its nearby chemical conversion facilities for processing. Lithcoa is a fully integrated producer of lithium compounds, metal, and metal derivatives. According to Gulf Resources and Chemical Corp.'s annual report for 1976, sales exceeded \$34 million and were 11% greater than 1975's record level. The mine and beneficiation plant continued to experience excellent ore grade and recovery. Production and concentrate grade were both at record levels. During the year, the decision was made to install additional filtration and flotation equipment, which will increase the beneficiation plant's capacity to a level sufficient to supply the chemical plant's concentrate requirement, resulting in the total integration of the productive facilities of the company. Also, construction was begun on a circuit to recover mica values from beneficiation plant tailings.

Chemical plant production was near rated capacity. Process recoveries were higher in 1976 than in the previous year because of the continuation of an intensive process-improvement program and the availability of higher grade ore concentrates from the beneficiation plant.

During the year, Lithcoa minimized its energy-related problems by direct purchase of a portion of its natural gas needs from a supplier in Louisiana. The company continued to improve pollution control techniques during 1976. A major modification of the wastewater treatment facility at the chemical plant was completed.

Lithcoa continued its strategy of pursuing new products and applications through the coordinated efforts of the sales and research and development departments. It made the first commercial sales of a new catalyst, dibutyl-magnesium, which is used in the polymerization of high density polyethylene. The company continued to respond to and support the needs of the lithium battery market, which is projected by some sources to grow significantly over the next decade. The report concluded by stating that the outlook for continued growth at Lithcoa is excellent;

sales and earnings are expected to increase further in 1977.

Sales by Lithcoa's Spartan Mineral Division, which produces feldspathic products for the manufacture of whiteware and glass, increased 22% but were below company expectations.

Mica.—North Carolina again led the Nation in scrap and flake mica production, as it has for many years. Total output of crude scrap and flake decreased 7%, but value increased 16% above that of 1975. Total output used and sold was 70,000 tons valued at \$3.8 million. Eight companies with 10 operations in 5 counties reported production to the Bureau of Mines. Leading producing companies in output were Kings Mountain Mica Co., Inc., with two operations in Cleveland County; Harris Mining Co., Avery and Mitchell Counties; and The Feldspar Corp., with two operations in Mitchell County. Four operations in Mitchell County produced 22,744 tons of mica valued at \$474,314. Cleveland County, with three operations, followed in output. Other producers were Piedmont Minerals, Inc., Orange County; International Minerals & Chemical Corp. and Lawson-United Feldspar and Mineral Co., Mitchell County; Foote Mineral Co., Cleveland County; and Deneen Mica Co., Yancey County.

Ground mica was produced by 11 companies operating 12 plants. Eight companies produced dry-ground mica, three companies produced wet-ground mica, but only one company produced both wet- and dry-ground mica. Total wet-ground output was 57,000 tons valued at \$4.1 million; total dry-ground output was 13,000 tons valued at over \$3.0 million. Principal uses of both wet- and dry-ground mica were for joint cement, well drilling and other

undesignated use. In addition, smaller quantities of the mica were used in the manufacture of paint, rubber, roofing, plastics, and wallpaper.

Olivine.—North Carolina continued to lead the Nation in output of olivine. International Minerals & Chemical Corp. operated two mines, one in Avery County and one in Yancey County. Output and value decreased below that of 1975.

Perlite.—Carolina Perlite Co., Inc., Gold Hill, expanded perlite from out-of-State sources. The material was used primarily for insulation, as horticultural and agricultural aggregate, and as construction aggregate. Output and value cannot be disclosed.

Phosphate Rock.—Output of phosphate rock at the Lee Creek operation of Texasgulf, Inc., Beaufort County, increased slightly in tonnage but more than doubled in value, due to a sharp increase in the price of the rock during the year. Exports increased substantially in tonnage and value over that of 1975. As in the previous year, most of the concentrate was used in the manufacture of wet-process phosphoric acid, and dry triple superphosphate.

Texasgulf, Inc., was the only phosphate rock-producing company in the State. According to Texasgulf's 1976 annual report, phosphate rock production increased 15.5% over that of 1975; phosphoric acid production increased 7.5%; and dry fertilizers increased 14.9%. According to the same report, the company continued its expansion program. The fourth sulfuric and phosphoric acid units, which started up in the last quarter of 1975, increased production capacity 170,000 tons to a total of 680,000 tons of 100% P_2O_5 per year.

A new 255,000 granular triple superphosphate plant and a new superphos-

Table 5.—North Carolina: Ground mica sold or used by producers, by use

Use	1975		1976	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Roofing -----	6,832	\$346,863	3,270	\$146,436
Paint -----	8,363	1,805,767	7,199	1,542,331
Rubber -----	4,300	932,334	4,680	1,010,300
Joint cement -----	16,914	1,364,781	22,860	1,997,511
Other uses ¹ -----	30,307	1,674,318	31,491	2,463,641
Total -----	66,716	6,124,063	69,500	7,160,219

¹ Includes brick, plastics, textile coating, wallpaper, well drilling, and other uses.

phoric acid unit, with an annual capacity in excess of 125,000 tons of 70% P_2O_5 , were also completed at yearend 1975. Both plants began production in the first quarter of 1976. Two additional 500,000-ton-per-year, fluid-bed calcining units began operations in January 1976.

A new 30-inch Ellicott suction dredge was completed and began removing overburden in February 1976. A new 50-cubic-yard dragline and dredge will increase mining capacity from an ore-mining rate of 3.5 million tons to 5 million tons per year. This will provide sufficient rock for the expansion of acid-plant production from the present 680,000 tons of P_2O_5 per year to 1 million tons, plus the rock required for triple superphosphate production, and about 500,000 tons of phosphate rock for sale each year.

At Lee Creek, Texasgulf owns or leases about 35,000 acres containing approximately 2.2 billion tons of phosphate sands averaging about 13% P_2O_5 , of which 1.2 billion tons is proven recoverable reserves.

During the year, Texasgulf acquired a liquid-fertilizer facility in the State. The plant was purchased in June 1976 and is located in Mt. Olive, about 115 miles west of Lee Creek. The plant will produce a clear 10-34-0 liquid-fertilizer base material, designated "Tgreen." With increased use of liquid fertilizers, sales from the plant are expected to increase to about 1,000 product tons per month over the next few years.

In other phosphate developments, North Carolina Phosphate Corp. (NCP) announced plans in 1974 to develop a large phosphate rock mining operation in Beaufort County, adjacent to Texasgulf's operation, and continued to acquire the necessary permits and complete studies leading to the establishment of the new mine. The U.S. Army Corps of Engineers has delayed ruling on the company's request for a dredge and fill permit for a 4.7-mile channel in South Creek and an inland turning basin to aid in the barge shipping of concentrate. In addition, several environmental groups have opposed the project on the

grounds that wildlife habitats will be disturbed by the barge traffic.

Sand and Gravel.—Total sand and gravel production increased 11% in quantity and 17% in value, over 1975 levels. Total output of construction and industrial sand was 9.0 million tons valued at \$18.3 million. Sand and gravel was produced at 152 operations in 63 counties. Leading counties, listed in order of descending rank of output, were Anson, Harnett, Cumberland, and Buncombe, and accounted for 47% of the State's output of sand and gravel. The North Carolina State Highway Commission was a large noncommercial sand and gravel producer.

Construction sand and gravel again comprised the bulk of the material produced. Total output was 8.3 million tons valued at \$14.3 million. Seventy companies produced construction sand and gravel at 144 operations. Principal uses of processed construction sand and gravel were in concrete aggregate for residential and non-residential construction, concrete products, and for bituminous paving, roadbase, and subbase. Unprocessed construction sand was used for roadbase, fill, and other uses.

Of the 144 construction sand and gravel operations in the State, 76 produced less than 25,000 tons for 10% of the total; 28 operations produced from 25,000 to 49,999 tons for 14% of the total; 27 operations produced from 50,000 to 99,999 tons for 25% of the total; 12 operations produced from 100,000 to 499,999 tons for 35% of the total; and 1 operation produced over 1 million tons, accounting for the remaining 16% of the construction material.

Industrial sand and gravel was produced at 9 operations by 8 companies; total output was 740,000 tons valued at \$3.9 million. The material was used principally for metallurgical uses, in the manufacture of glass, as a blasting medium, and for filtration purposes.

Sand and gravel produced during the year was transported 79% by truck, 20% by rail, and 1% by other methods. A total of 364,000 tons was used at the pit site and not transported.

Table 6.—North Carolina: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Alamance	1	W	W	--	--	--
Anson	2	W	W	2	W	W
Avery	1	W	6	2	W	68
Beaufort	3	W	W	3	W	W
Bertie	5	109	164	5	179	227
Bladen	1	W	W	1	W	W
Brunswick	--	--	--	2	47	14
Buncombe	4	449	967	4	489	1,206
Burke	1	W	W	2	W	W
Cabarrus	3	198	149	3	133	122
Caldwell	2	W	W	2	W	W
Camden	1	W	W	1	W	W
Catawba	6	233	271	6	113	163
Chowan	1	3	1	1	4	1
Cleveland	4	126	190	6	235	600
Craven	1	62	W	1	62	W
Cumberland	6	524	680	5	568	878
Currituck	1	W	W	1	W	W
Davidson	1	W	W	1	W	W
Davie	1	W	W	2	W	W
Duplin	2	W	W	2	W	W
Edgecombe	3	178	249	2	W	W
Forsyth	--	--	--	1	W	W
Franklin	1	50	126	1	73	151
Gaston	6	W	W	5	31	W
Greene	1	W	W	1	W	W
Guilford	3	180	72	3	238	414
Harnett	2	W	W	2	W	W
Hertford	4	8	W	2	W	W
Hyde	1	8	2	1	5	1
Iredell	--	--	--	1	10	W
Jackson	1	52	W	--	--	--
Johnston	4	38	49	3	27	W
Jones	1	W	12	1	W	12
Lee	2	W	W	2	W	W
Lenoir	3	W	W	3	W	W
McDowell	5	234	524	4	255	615
Macon	1	14	W	1	67	W
Martin	1	32	8	1	54	16
Mitchell	--	--	--	2	W	W
Montgomery	3	109	98	4	167	336
Moore	2	W	W	3	221	307
New Hanover	2	W	81	2	W	57
Northampton	4	63	37	2	W	W
Onslow	1	W	W	1	W	W
Orange	2	W	W	2	W	W
Pasquotank	3	59	41	2	W	W
Pitt	3	124	174	4	126	172
Richmond	3	210	730	4	468	1,562
Robeson	1	W	18	1	W	16
Rockingham	5	97	200	4	77	171
Rowan	4	W	W	4	17	W
Rutherford	1	W	W	--	--	--
Sampson	3	W	W	3	W	W
Scotland	1	W	W	1	W	W
Stokes	--	--	--	1	18	31
Surry	3	W	W	3	W	W
Swain	1	W	W	1	W	W
Transylvania	1	8	18	1	14	20
Tyrrell	--	--	--	1	(¹)	(¹)
Wake	1	18	36	1	18	36
Washington	1	51	13	1	53	16
Wayne	11	154	222	12	174	253
Wilkes	1	89	205	2	W	W
Wilson	1	W	W	1	W	W
Yadkin	1	W	W	1	W	W
Yancey	3	W	W	2	W	W
Other counties ²	--	4,699	10,269	--	5,099	10,819
Total ³	148	8,169	15,610	152	9,049	18,287

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

¹ Less than 1/2 unit.

² Includes some sand and gravel that cannot be assigned to specific counties, and items indicated by symbol W.

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

Table 7.—North Carolina: Construction and industrial sand and gravel sold or used by producers, in 1976

(Thousand short tons and thousand dollars)

Use	Quantity	Value	Value per ton
Construction:			
Sand -----	6,080	8,318	\$1.38
Gravel -----	2,279	6,024	2.64
Total -----	8,309	¹ 14,344	1.73
Industrial:			
Sand -----	721	3,753	5.21
Gravel -----	19	190	10.00
Total -----	740	3,943	5.33
Grand total -----	9,049	18,287	2.02

¹ Data do not add to total shown because of independent rounding.**Table 8.—North Carolina: Construction sand and gravel sold or used, by major use category, in 1976**

(Thousand short tons and thousand dollars)

Use	Quantity	Value	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	2,875	5,953	\$2.07
Concrete products (cement blocks, bricks, pipe, etc.) -----	1,471	2,710	1.84
Asphaltic concrete aggregates and other bituminous mixtures -----	1,129	2,042	1.81
Roadbase and coverings -----	1,815	2,706	1.49
Fill -----	493	442	.90
Other uses -----	526	489	.93
Total -----	8,309	¹ 14,344	1.73

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

Stone.—Stone was the leading mineral commodity produced in the State during 1976. Total stone output was 30.9 million tons valued at \$82.5 million, compared with 28.3 million tons valued at \$69.3 million in 1975. Increased output was indicative of a partial recovery by the building and construction industry from the downturn of 1975. Production of all types of stone came from 101 quarries located in 54 counties of the State. Twenty-six quarries with individual production of 500,000 tons or more accounted for over 63% of the State's total stone production by quantity; seven of these quarries each produced 900,000 tons or more and accounted for over 23% of the total State output. Thirty-four quarries each produced from 100,000 to 500,000 tons of stone, and 41 quarries each produced from less than 25,000 tons up to 100,000 tons of stone.

The leading stone-producing companies in the State were Martin Marietta Corp.

with 23 quarries, Vulcan Materials Co. with 12 quarries, and Nello L. Teer Co. with 6 quarries. These three companies were responsible for 74% of the total value. Other companies operating three or more quarries were Jacob Creek Stone Co., Inc. (five), B. V. Hedrick Sand and Gravel Co. (four), Fifth Wheel Materials, Inc. (three), and Ashland Oil, Inc., Harrison Div. (three). Leading counties in production of crushed and broken stone, listed in decreasing order of output, were Mecklenburg, Guilford, Wake, Surry, New Hanover, Craven, Buncombe, and Edgecombe. These eight counties each had production of over 1 million tons and accounted for 40% of the total stone production in the State.

North Carolina ranked second among the States in output of crushed granite, third in crushed marble and crushed miscellaneous stone, and fifth in dimension slate.

Crushed stone was produced by 36 companies at 88 quarries throughout the State; output increased 9% over that of 1975 to 30.8 million tons valued at \$78.6 million. Crushed and broken granite was produced at 58 quarries and accounted for 75% of total stone output and 70% of the total value. The average value per ton of crushed and broken granite was \$2.51, compared with \$2.29 in 1975. The principal uses for crushed and broken granite, listed in decreasing order of quantity, were for dense roadbase, as unspecified aggregate, concrete aggregate and bituminous aggregate. Other important uses were for railroad ballast, surface trim, riprap, and jetty stone. One company produced crushed granite for use as poultry grit.

Dimension stone was quarried by eight companies for curbing, dressed construction stone, rough construction stone, and other uses. Total output declined 20% below that of 1975 to 37,606 tons valued at \$3.8 million. Dimension granite was produced at nine quarries; total output was 380,000 cubic feet valued at \$3.2 million. Principal uses for dimension granite were for curbing, construction, cut stone, and for monumental purposes.

Crushed and broken limestone was produced at eight quarries. Total output was 4.1 million tons valued at \$10.8 million. Unit value per ton of limestone produced was \$2.63. Principal uses of the limestone, listed in decreasing order of tonnage, were

for unspecified aggregate, bituminous aggregate, concrete aggregate, in cement manufacture, and as railroad ballast.

Both crushed and broken marble and dimension marble were produced. Four quarries produced crushed and broken marble for terrazzo and unspecified aggregate uses. Three quarries produced dimension marble for monumental, construction, and rough block uses.

Marl was produced at five quarries; total output was 173,000 short tons valued at \$321,000. Most of the material was used for fill purposes and as agricultural marl for soil-conditioning purposes.

Traprock was produced at four quarries; total output was 1.7 million tons valued at \$4.9 million. Unit value per ton was \$2.88. Most of the material was used for dense roadbase, concrete aggregate, and in bituminous aggregate.

Dimension slate was produced at only one quarry during the year. Output and value are confidential and cannot be divulged.

Sandstone, both crushed and broken, and dimension sandstone was produced at eight quarries. Crushed and broken stone for use in glass, cement manufacture, and as unspecified aggregate was produced at five quarries. Dimension sandstone for construction and flagging uses was produced at three quarries. Total output and value cannot be divulged.

Table 9.—North Carolina: Crushed granite sold or used by producers, by county

County	1975			1976		
	Number of quarries	Quantity (short tons)	Value (thousands)	Number of quarries	Quantity (short tons)	Value (thousands)
Ashe -----	1	126,000	W	1	W	W
Cabarrus -----	1	59,690	\$107	1	W	W
Caldwell -----	1	270,500	W	1	348,000	\$1,027
Guilford -----	4	2,063,182	4,830	4	2,058,390	5,271
Richmond -----	1	275,500	W	1	472,985	1,262
Surry -----	3	1,257,795	2,297	3	1,644,488	3,206
Wake -----	5	1,843,972	4,242	4	1,696,719	4,387
Undistributed ¹ -----	50	16,406,798	39,497	43	16,759,398	42,610
Total -----	66	22,303,437	50,973	58	22,979,980	57,763

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

¹ Includes Alamance, Anson, Buncombe, Burke, Caswell, Catawba, Chatham (1975), Cherokee, Cleveland (1975), Davidson, Davie, Edgecombe, Forsyth, Gaston, Haywood, Henderson, Iredell, Jackson, Lee, Macon, Mecklenburg, Mitchell (1975), Nash (1975), Orange, Pitt, Polk, Rockingham, Rowan, Rutherford, Swain (1975), Transylvania, Union (1975), Vance, Watauga, Wilkes, Wilson, and Yadkin (1975) Counties, and counties indicated by symbol W.

Table 10.—North Carolina: Crushed stone, sold or used by producers,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	13,540	30,650	8,184	18,370
Roadstone -----	2,593	5,835	7,292	18,880
Concrete aggregate -----	5,158	12,553	5,824	15,510
Bituminous aggregate -----	3,556	8,954	5,335	14,400
Railroad ballast -----	714	1,672	1,599	4,050
Surface treatment aggregate -----	842	2,116	765	2,110
Riprap and jetty stone -----	326	908	272	831
Macadam aggregate -----	724	927	W	W
Terrazzo and exposed aggregate -----	15	87	19	351
Mineral food -----	18	166	W	W
Other uses ² -----	772	1,951	1,549	4,130
Total ³ -----	28,261	65,825	30,839	78,632

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

¹ Includes granite, limestone, traprock, miscellaneous stone, marl, sandstone, marble, and slate.

² Includes cement manufacture, fill, soil conditioning, glass (1976), agriculture limestone, other uses, and uses indicated by symbol W.

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

Table 11.—North Carolina: Dimension stone, sold or used by producers,¹ by use

Use	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Curbing -----	17,130	\$887	15,680	\$1,078
Cut stone -----	3,217	603	3,080	739
Rough monumental -----	4,976	263	2,020	95
Rough blocks -----	2,424	97	1,676	46
Rubble -----	2,241	29	1,110	16
Other uses ² -----	16,950	1,623	14,040	1,855
Total ³ -----	46,937	3,502	37,606	3,830

¹ Includes granite, sandstone, slate, marble, and miscellaneous stone.

² Includes dressed construction, rough irregular-shaped stone, sanitary fixture, dressed monumental, rough flagging, and dressed flagging.

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

Talc and Pyrophyllite.—In 1976, North Carolina was the only pyrophyllite-producing State in the Nation. The combined production of talc and pyrophyllite increased 19% over that of 1975 but decreased 32% in value below that of 1975. Talc was produced by only one company, Hitchcock Corp. in Cherokee County. The principal uses for the talc were in the manufacture of toilet preparations and by the textile industry. Both sawed and ground talc was produced. Pyrophyllite was produced by five companies in four counties. Total output and value showed a slight increase over that of 1975. Leading producers were Piedmont Minerals Co., Inc., near Hillsborough, Orange County; Standard Minerals Co., near Robbins, Moore County; and Glendon Pyro-

phyllite, Inc., with mines in Alamance and Moore Counties. Most of the pyrophyllite was processed and used by the ceramic and refractory industries.

Vermiculite.—Two companies exfoliated vermiculite from crude ore mined in South Carolina. W. R. Grace & Co. operated a plant near High Point, Guilford County, and produced material used for block insulation, concrete aggregate, loose fill insulation, horticulture, and plaster aggregates. Carolina Wholesale Florist, Inc., produced a small tonnage of exfoliated vermiculite for horticulture and loose-fill insulation use.

METALS

Aluminum.—Primary aluminum was produced by the Aluminum Co. of Amer-

ica (Alcoa) at a plant near Badin, Stanly County, using imported alumina. Output of metal decreased slightly, but value increased over that of 1975. In addition to its smelting operation, Alcoa operated an electric public utility, Nantahala Power & Light Co., near Franklin, Macon County, and an aluminum metal fabricating facility near Laurinburg, Scotland County.

Tungsten.—There was no recorded production of tungsten in North Carolina during 1976. Ranchers Exploration and Development Corp. continued to keep its Tungsten Queen mine and mill near Townsville, Vance County, in a standby

condition. There has been no production since 1971 when the mine was closed.

MINERAL FUELS

There was no production of mineral fuels in North Carolina during 1976.

Petroleum and Natural Gas.—According to the Oil and Gas Section, Office of Earth Resources, there was no exploratory oil or gas wells drilled in the State during 1976. Cities Service Oil Co. and Colonial Oil and Gas Co. continued to hold leases on State-owned submerged lands for oil and gas exploration in the coastal areas of the State.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, smelter:			
Aluminum Company of America.	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant -----	Stanly.
Asbestos:			
Powhatan Mining Co. ----	6721 Windsor Mill Rd. Baltimore, Md. 21207	Open pit mine ----	Yancey.
Cement:			
Ideal Basic Industries, Inc. ^{1,2}	420 Ideal Cement Bldg. Denver, Colo. 80202	Plant -----	New Hanover.
Clays:			
Boren Clay Products Co. ---	Pleasant Garden, N.C. 27313	Open pit mines and plant.	Chatham, Guilford, Sampson.
Pine Hall Brick & Pipe Co.	Box 11044 Winston-Salem, N.C. 27106	----do -----	Rockingham and Stokes.
Sanford Brick Corp. -----	Box 38 Gulf, N.C. 27256	----do -----	Chatham, Lee, Stanly.
Solite Corp. -----	Box 9138 Richmond, Va. 23227	----do -----	Rockingham and Stanly.
Feldspar:			
The Feldspar Corp. ^{1,2,3} ----	Spruce Pine, N.C. 28777	Open pit mines and plants.	Mitchell.
Lawson-United Feldspar and Mineral Co. ³	Minipro, N.C. 28777	----do -----	Do.
Sobin Chemicals, Inc. ³ ----	Old Orchard Rd. Skokie, Ill. 60079	----do -----	Do.
Iron ore:			
Greenback Industries, Inc. -	Greenback, Tenn. 37742	Underground mine and plant.	Avery.
Lithium minerals:			
Foote Mineral Co. ¹ -----	Box 792 Kings Mountain, N.C. 28086	Open pit mine and plant.	Cleveland.
Lithium Corp. of America, Inc.	449 N. Cox Rd. Gastonia, N.C. 28052	----do -----	Gaston.
Mica:			
Harris Mining Co. ^{1,2} -----	Box 628 Spruce Pine, N.C. 28777	Open pit mines ---	Avery and Mitchell.
Kings Mountain Mica Co., Inc. ⁴	Box 709 Kings Mountain, N.C. 28086	----do -----	Cleveland.
Olivine:			
International Minerals & Chemical Corp.	Box 672 Spruce Pine, N.C. 28777	----do -----	Avery and Yancey.
Perlite, expanded:			
Carolina Perlite Co., Inc. --	Box 741 Hillside, N.J. 07205	Plant -----	Rowan.
Phosphate rock:			
Texasgulf, Inc. -----	200 Park Ave. New York, N.Y. 10017	Open pit mine and plant.	Beaufort.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Barrus Construction Co ---	Box 399 Kingston, N.C. 28501	Pits -----	Various.
Becker Sand & Gravel Co --	Box 848 Cheraw, S.C. 29520	----do -----	Cumberland, Harnett, Moore.
W. R. Bonsal Co -----	Box 38 Lilesville, N.C. 28091	----do -----	Anson.
B. V. Hedrick Gravel and Sand Co. ¹	Swannanoa, N.C. 28778	----do -----	Buncombe.
Stone:			
Arrarat Rock Products Co.	223 Willow St. Mt. Airy, N.C. 27030	Quarry -----	Surry.
Ashland Oil Co., Harrison Div.	Box 386 Alcoa, Tenn. 37701	Quarries -----	Cherokee, Jackson, Macon.
Martin Marietta Corp ----	Box 30013 Raleigh, N.C. 27612	----do -----	Various.
Nello L. Teer Co. ⁵ -----	Box 1131 Durham, N.C. 27702	----do -----	Do.
Vulcan Materials Co -----	Box 7506, Reynolds Station Winston-Salem, N.C. 27106	----do -----	Do.
Talc and pyrophyllite:			
Glendon Pyrophyllite, Inc.	Box 306 Carthage, N.C. 28327	Open pit mines and plant. -----	Alamance and Moore.
Hitchcock Corp -----	Box 459 Murphy, N.C. 28906	----do -----	Cherokee.
Piedmont Minerals Co., Inc.	Box 7247 Greensboro, N.C. 27407	Open pit mine and plant. -----	Orange.
Standard Minerals Co., Inc.	Robbins, N.C. 27325	----do -----	Moore.
Vermiculite, expanded:			
Carolina Wholesale Florists, Inc.	Box 537 Sanford, N.C. 27330	Plant -----	Lee.
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, Mass. 02140	----do -----	Guilford.

¹ Also stone.² Also clays.³ Also mica.⁴ Also feldspar.⁵ Also sand and gravel.

The Mineral Industry of North Dakota

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the North Dakota Geological Survey under a cooperative agreement for collecting information on minerals.

By Harold J. Polta¹ and Charles A. Koch²

Mineral output in North Dakota in 1976 was valued at \$244.1 million, up 21% from that of 1975. Petroleum continued to be the State's principal mineral commodity, accounting for about 70% of total State mineral output value. Coal was the second leading commodity with a value of \$41.5 million, about 17% of total value. Natural gas accounted for 4%, and sand and gravel, for 3%.

Total value of petroleum production in-

creased \$20.7 million, or 13.8% over that of 1975; value of coal increased \$14.5 million, or 53.7%; value of natural gas increased \$5 million, or 87.7%. The total value of sand and gravel output, the only major nonmetallic mineral, was \$8.3 million, \$212,000 more than in 1975.

¹ State Liaison Officer (now deceased), Bureau of Mines, Bismarck, N. Dak.

² State Liaison Officer, Bureau of Mines, Cheyenne, Wyo.

Table 1.—Mineral production in North Dakota¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Coal -----thousand short tons--	8,515	\$27,010	11,102	\$41,507
Gem stones -----	NA	2	NA	2
Natural gas -----million cubic feet--	24,786	5,701	31,470	10,699
Petroleum (crude) ---thousand 42-gallon barrels--	20,452	149,705	21,725	170,411
Sand and gravel -----thousand short tons--	5,636	8,133	5,171	8,345
Stone -----do-----	30	153	--	--
Value of items that cannot be disclosed:				
Clays, lime, natural gas liquids, peat, and salt -	XX	10,800	XX	13,141
Total -----	XX	201,504	XX	244,105
Total 1967 constant dollars -----	XX	79,735	XX	87,766

¹ Preliminary. NA Not available. XX Not applicable.

² Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of mineral production in North Dakota, by county ^{1 2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value.
Adams	—	W	Coal.
Barnes	\$199	\$151	Sand and gravel.
Benson	29	—	Do.
Billings	W	W	Petroleum.
Bottineau	W	W	Petroleum, sand and gravel, peat.
Bowman	W	W	Petroleum, coal, sand and gravel.
Burke	10,300	W	Petroleum, coal, natural gas liquids.
Burleigh	604	1,585	Sand and gravel.
Cass	W	W	Do.
Dickey	34	28	Do.
Divide	W	W	Petroleum, sand and gravel.
Dunn	W	W	Do.
Eddy	W	826	Sand and gravel.
Golden Valley	W	400	Petroleum.
Grand Forks	247	W	Sand and gravel.
Grant	30	W	Coal.
Griggs	W	W	Sand and gravel.
Kidder	W	W	Do.
McHenry	W	W	Petroleum.
McKenzie	31,269	W	Petroleum, sand and gravel.
McLean	617	778	Sand and gravel.
Mercer	W	W	Coal.
Morton	W	W	Sand and gravel, clays.
Mountrail	2,263	W	Petroleum, sand and gravel.
Nelson	W	W	Sand and gravel.
Oliver	W	W	Coal, sand and gravel.
Pembina	W	W	Lime, sand and gravel.
Pierce	87	49	Sand and gravel.
Ramsey	15	23	Do.
Ransom	W	W	Do.
Renville	W	W	Petroleum, sand and gravel.
Richland	W	W	Lime, sand and gravel.
Rolette	61	18	Sand and gravel.
Sheridan	147	10	Do.
Slope	W	W	Petroleum, sand and gravel.
Stark	W	W	Petroleum, sand and gravel, coal.
Stutsman	410	400	Sand and gravel.
Towner	W	96	Do.
Trail	216	354	Do.
Walsh	452	170	Do.
Ward	W	W	Coal, sand and gravel, petroleum.
Wells	118	118	Sand and gravel.
Williams	41,608	45,703	Petroleum, natural gas liquids, salt, sand and gravel.
Undistributed ³	112,799	193,395	
Total ⁴	201,504	244,105	

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

¹ The following counties are not listed because no production was reported: Cavalier, Emmons, Foster, Hettinger, La Moure, Logan, McIntosh, Sargent, Sioux, and Steele.

² Value of petroleum is based on an average price per barrel for the State.

³ Includes gem stones, natural gas, some sand and gravel which cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of North Dakota business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	268	279	+4.1
Unemployment -----do-----	13.3	10.0	-24.8
Employment (nonagricultural):			
Mining -----do-----	2.1	2.5	+19.0
Manufacturing -----do-----	16.2	16.1	-.6
Contract construction -----do-----	13.9	15.8	+13.7
Transportation and public utilities -----do-----	12.7	13.1	+3.1
Wholesale and retail trade -----do-----	56.6	60.7	+7.2
Finance, insurance, real estate -----do-----	8.5	9.1	+7.1
Services -----do-----	39.1	41.1	+5.1
Government -----do-----	54.5	56.2	+3.1
Total nonagricultural employment ----do-----	203.6	214.6	+5.4
Personal income:			
Total -----millions--	\$3,781	\$3,761	-.5
Per capita -----do-----	\$5,936	\$5,846	-1.5
Construction activity:			
Number of private and public residential units authorized -----do-----	5,144	6,097	+18.5
Value of nonresidential construction -----millions--	\$46.7	\$54.1	+15.8
Value of State road contract awards -----do-----	\$60.6	\$39.6	-34.7
Shipments of portland and masonry cement to and within the State -----thousand short tons--	380	422	+11.1
Mineral production value:			
Total crude mineral value -----millions--	\$201.5	\$244.1	+21.1
Value per capita, resident population -----do-----	\$316	\$380	+20.2
Value per square mile -----do-----	\$2,852	\$3,454	+21.1

^P Preliminary.

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

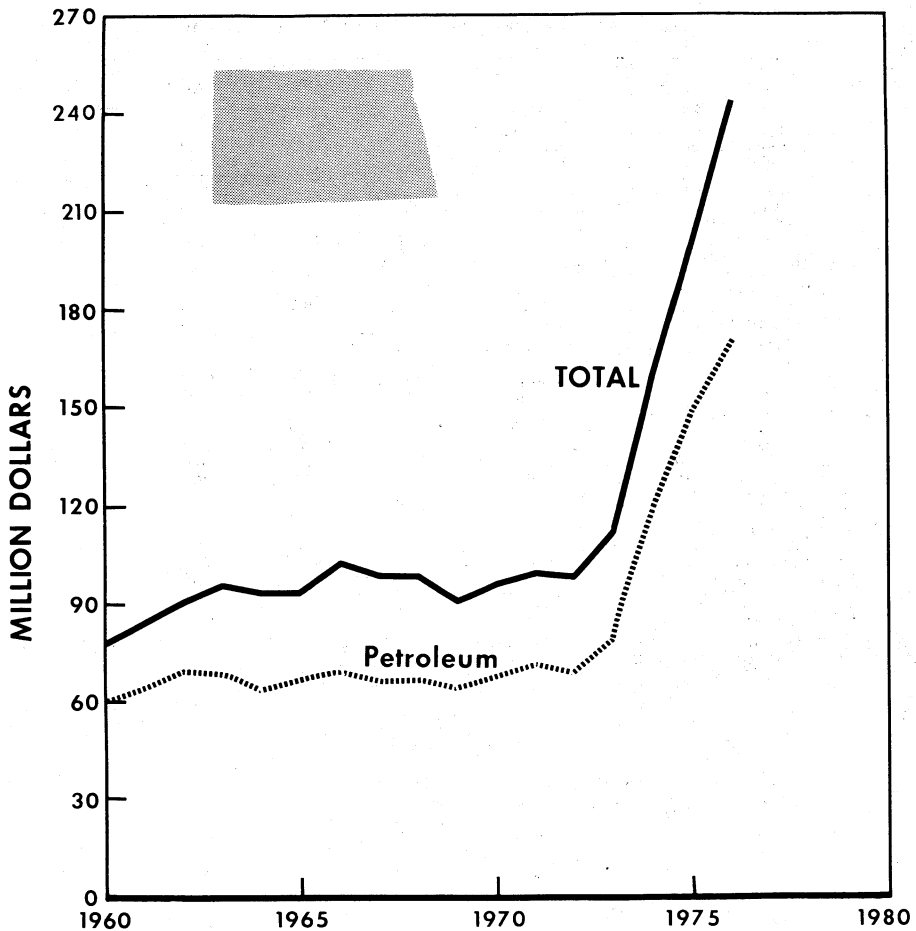


Figure 1.—Value of petroleum and total value of mineral production in North Dakota.

Legislation and Government Programs.—The State Legislature did not meet in 1976, but the activities of the State Legislative Council and its committees indicated that coal development and its impact on North Dakota would receive considerable attention by the 1977 session of the State Legislature.

Following the Secretary of the Interior's announcement on January 26, 1976, of a new comprehensive Federal coal-leasing policy, a massive effort was launched to compile information concerning all aspects of coal development in North Dakota. The U.S. Bureau of Land Management was

designated the lead Federal agency in the preparation of a Regional Environmental Impact Statement. The analyses of environmental impacts of coal development became a joint effort by the Federal and State Governments through a memorandum of understanding and agreement between the Secretary of the Interior and the Governor of North Dakota.

The North Dakota Geological Survey continued a geologic mapping and exploration program, including drilling, to evaluate coal and other mineral deposits in the State. The Survey was also involved in studies related to mined land reclama-

tion and ground water. Selected reports summarizing results were published.³

The United States Geological Survey (USGS) had several teams of geologists in the field mapping geology, with emphasis on the areas containing Federal coal. The Survey's hydrologic branch continued to collect basic hydrologic and water-quality data.

The U.S. Department of Agriculture, North Dakota State University, and the University of North Dakota, in active

cooperation with industry, continued to spend considerable amounts of money on strip mine spoil bank reclamation. The objective of the effort was to restore the land to its most productive use.

At its Grand Forks research center, ERDA continued and expanded research on coal gasification formerly conducted by the U.S. Bureau of Mines. The research was initiated to extend process efficiencies and capabilities and to find ways to reduce detrimental environmental effects.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Lignite).—Coal production in 1976 was a record 11.1 million tons, up 30.4% from the 8.5 million tons produced in 1975. The tonnage produced accounted for 1.6% of the total U.S. bituminous coal and lignite production in 1976, compared with 1.3% of total U.S. production in 1975. Total value of coal produced was \$41.5 million, compared with \$27 million in 1975.

Average value of coal, f.o.b. mine, was \$3.74 per ton in 1976, compared with \$3.17 per ton in 1975.

All coal production was by strip mining methods using large draglines for stripping. Power shovels and front-end loaders were used for mining the coal.

Mercer County continued as the leading lignite producer; other major producing counties were Bowman and Oliver.

Table 4.—North Dakota: Lignite strip production, by county, in 1976

(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines	Production (thousand short tons)	Value (thousands)
Adams -----	1	W	W
Bowman -----	1	W	W
Burke -----	1	W	W
Grant -----	1	W	W
Mercer -----	3	W	W
Oliver -----	2	W	W
Stark -----	1	W	W
Ward -----	1	W	W
Total ---	11	11,102	\$41,507

W Withheld to avoid disclosing company proprietary data; included in "Total."

Principal coal producers in 1976 were Baukol-Noonan, Inc., operator of the Noonan mine near Larson and the Center mine near Center; Consolidation Coal Co., operator of the Glenharold mine near Stanton and the Velva mine near Velva; Knife River Coal Mining Co., operator of the Gascoyne mine near Gascoyne and the South Beulah mine near Beulah; and North American Coal Corp. (NACCO), operator of the Indian Head mine near Zap. Collectively, these four companies accounted for 99% of State coal production in 1976.

Most of North Dakota coal production was for consumption at nearby, in-State powerplants, the only major exception being Knife River Coal Mining Co.'s shipments to the Otter Tail Power Co. 440-megawatt plant at Big Stone City, South Dakota, which went into operation in May 1975.

Consolidation Coal Co. increased production capacity of its Glenharold mine to about 3.8 million tons per year because of an addition to the Basin Electric Power

³ Bluemle, John P. *The Prairie: Land and Life*, ED-10.

Clayton, L., S. R. Moran, and W. B. Bickley, Jr. *Stratigraphy, Origin and Climatic Implications of Late Quaternary Upland Silt in North Dakota*. N. Dak. Geol. Survey, Misc. Series No. 54, 1976.

Cook, C. W. *A Mechanical Well Log Study of the Poplar Interval of the Mississippian Madison Formation in North Dakota*. RI-52.

Moore, Walter L. *The Stratigraphy and Environments of Deposition of the Cretaceous Hell Creek Formation (Reconnaissance) and the Paleocene Ludlow Formation (Detailed)*, Southwestern North Dakota. N. Dak. Geol. Survey, Rept. Inv. 56, 1976.

North Dakota Geological Survey. *Preliminary Report on 1975 Drilling of Lignites in Western N.D.*: Adams, Bowman, Dunn, Hettinger, McLean, Mercer, Oliver, Slope, and Williams Counties. Open File Report 76-869, 1976.

Cooperative generating facility at Stanton. The 440-megawatt addition to the Leland Olds generating station was completed in late 1975 and was in full operation when formally dedicated on June 16, 1976.

Future consumption by powerplants already under construction will boost North Dakota coal production to 20 million tons annually by 1980, an 80% increase over 1976 production. Planned powerplant construction could boost production by 350% over that of 1976 to over 50 million tons during the 1980-85 period.

Production at the Baukol-Noonan Center mine is expected to increase to over 4 million tons annually with completion of the 400-megawatt addition to Minnkota Power Cooperative's Milton R. Young powerplant. This \$225 million addition was scheduled for completion in 1977.

NACCO's production is expected to increase 5.5 million to 6.0 million by 1980. Its subsidiary, The Falkirk Mining Co., started development of the Falkirk mine in August 1975, and will start stripping operations in January 1977. The entire production is for the \$500 million, 1,000-megawatt Coal Creek electric generating complex under construction near Falkirk by United Power Association and Cooperative Power Association. First deliveries from the Falkirk mine are scheduled for May 1978, with the mine reaching full production capacity in late 1979 or early 1980.

Projected production increases by NACCO's subsidiary, The Coteau Properties Co., were revised during the year because of a change in plans by American Natural Resources Co. (formerly American Natural Gas Co.). American Natural scaled down its proposed 250-million-cubic-feet-per-day coal gasification complex to a 125-million-cubic-feet-per-day plant. The original plant would have required 14 million tons of coal per year from Coteau starting in 1981, but the new plant will require only half that amount. Revised plans made public late in 1976 call for completion of a 125 million cubic feet per day plant by 1981 at a cost of about \$900 million. This compares with a 1973 estimate of \$400 million for a complete 250-million-cubic-feet-per-day gasification complex including gas plant and mine. The revised plans also include a construction agreement between American Natural and Basin Electric Cooperative whereby Coteau will supply coal

for Basin's proposed Antelope Valley Station. Basin in turn will supply power for operating the coal gasification plant.

Because of these construction plan changes, projected mine production was as follows: 1981, 5 million tons per year for a 125-million-cubic-feet-per-day coal gasification plant and 2.5 million tons per year for unit 1 of Basin's 880-megawatt Antelope Valley Station; and 1984-85, an additional 5 million tons per year for an increased gasification capacity to 250 million cubic feet per day, and 2.5 million tons more per year for an addition to the Antelope Valley Station.

Knife River Coal Mining Co. plans to increase production by 2 million to 2.5 million tons per year if a planned power project is completed near Beulah. Present plans call for completion in 1981 of the proposed 440-megawatt Coyote I powerplant by Montana-Dakota Utilities Co., Northwestern Public Service Co., and Otter Tail Power Co.

Amax Coal Co. may become another major coal producer in North Dakota by 1982 if progress continues on the Natural Gas Pipeline Company of America's plans to build a \$1 billion plus coal gasification complex in Dunn County. Operation of the complex would require an estimated 13 million to 14 million tons of coal annually.

Research and studies relating to all aspects of increased production and consumption of coal continued. Work underway included geologic mapping and drilling, continued collection of hydrologic and water-quality data, water-use studies, strip mine reclamation research, continued efforts to improve coal gasification and pollution control processes, social and economic impact studies, manpower availability studies and a multimillion dollar computerization effort to compile, retrieve, and manipulate the vast amount of information being generated. Both industry and Government were contributing to the intensive research and study effort.

U.S. Bureau of Mines mined land reclamation research continued at the University of North Dakota under a grant totaling more than \$1 million spanning a 5-year period. The grant continues research begun by the Bureau in 1973 at its Grand Forks energy research laboratory. (The research facility was incorporated into the Energy Research and Development Administra-

tion (ERDA) in January 1974.) The objective of Project Reclamation is to investigate the nature of spoil materials overturned in the process of coal mining so that better methods of restoring the land to original productivity can be developed.

Natural Gas.—Natural gas production totaled 31,470 million cubic feet, of which 10,301 million cubic feet went to public utilities for distribution to customers and 21,169 million cubic feet was returned to oilfields and gasfields for lease use, including gas lift operations. Most of the gas (casing head gas) was processed through the State's five gas plants. Production from the State's two producing gasfields totaled 285 million cubic feet. According to the North Dakota Geological Survey, the casing head gas received by the gas plants for processing totaled 31 million cubic feet, but this included an unknown but considerable quantity of recycled material. The average value of 34 cents per thousand cubic feet compares with 23 cents in 1975.

Natural Gas Liquids.—Production of natural gas liquids declined slightly in quantity, but increased 28% in value. The State's five operating gas plants and their capacities were as follows: Tioga plant, Aminoil USA, Inc., 40 million to 45 million cubic feet per day; Coyote Creek

plant, Farmers Union Central Exchange (CENEX), 3 million cubic feet per day; Boxcar Butte plant, Kerr-McGee Corp., 2 million cubic feet per day; Lignite plant, Texaco, Inc., 15 million cubic feet per day; and Red Wing Creek plant, True Oil Co., 10 million cubic feet per day.

Petroleum.—Petroleum production totaled 21.7 million barrels, an increase of 1.3 million barrels or 6.2% over that of 1975, but still 20% below the record high of 27.1 million barrels in 1966. North Dakota's 1976 production accounted for 0.7% of the total U.S. production, about the same as in 1975. Total value of crude oil produced was \$170.4 million, up \$20.7 million from its 1975 value of \$149.7 million. According to the North Dakota Geological Survey, the State had 2,123 wells capable of production at year-end 1976, compared to 1,963 at yearend 1975. Combined production rate of these wells at yearend was about 1.9 million barrels per month.

Most of the State's crude oil was refined in-State in Amoco Oil Co.'s Mandan refinery (with a processing capacity of 52,000 barrels per day at Mandan), Westland Oil Co.'s Williston refinery (5,000 barrels per day at Williston), and Northland Oil and Refining Co.'s refinery (2,000 barrels per day at Dickinson).

Table 5.—North Dakota: Oil and gas well drilling completions, in 1976 by county

County	Development		Wildcat		Outpost		Extension		Total wells
	Oil	Dry	Oil	Dry	Oil	Dry	Oil	Dry	
Billings	2	4	1	1	1	1	2	--	12
Bottineau	15	9	1	11	4	2	1	--	43
Bowman	9	1	--	3	2	2	5	1	23
Burke	11	3	1	5	--	--	2	2	24
Divide	--	2	--	2	--	--	--	--	4
Dunn	--	1	2	--	--	--	--	--	3
Golden Valley	--	1	--	1	--	--	1	--	3
Hettinger	--	--	--	1	--	--	--	--	1
McHenry	1	1	--	2	--	--	--	--	4
McKenzie	10	5	2	4	--	2	1	--	24
McLean	--	--	--	1	--	--	--	--	1
Morton	--	--	--	2	--	--	--	--	2
Mountrail	--	--	--	1	--	--	--	--	1
Pierce	--	--	--	2	--	--	--	--	2
Renville	15	7	1	18	2	7	8	6	64
Slope	--	2	--	2	--	--	--	1	5
Stark	2	3	--	3	--	1	--	2	11
Ward	--	3	--	8	1	--	1	1	14
Williams	5	2	--	1	--	1	1	--	10
Total	70	44	8	68	10	16	21	14	251

Source: North Dakota Geological Survey.

Number of wells completed during the year totaled 251, an increase of 154% over that of 1972, when drilling activity had declined to its lowest point since oil was discovered in North Dakota in 1951. The State Geological Survey classified 114 of the wells as development wells and 137 as wildcats and/or extension and outpost wells, located within 1½ miles of an established field boundary.

The 114 development wells drilled resulted in 70 producers and 44 dry holes; the 137 wildcat, extension, and outpost wells, in 39 producers and 98 dry holes.

Higher crude prices continued to stimulate wildcatting farther from producing areas and to greater depths. The increase in wildcatting resulted in the discovery of 16 new oil pools, only 3 less than the record high of 19 new discoveries made in 1957. The new pools discovered are scattered throughout nine western counties. According to the Survey, new discoveries occurred in all months except July and November.

The Red River pool in the Yellowstone field was the first new pool discovery and was reported to the North Dakota Geological Survey by Tiger Oil Co. on January 11. Crude production from this western McKenzie County wildcat was 360 barrels per day from the Red River formation at a depth of 12,898 to 12,995 feet.

The Franks Creek field Tyler pool, discovered in Billings County by Southern Union Product Co., was reported completed on February 14 at a total depth of 11,110 feet. Production of 152 barrels per day was reported from the Tyler Formation at a depth of 8,092 to 8,108 feet.

The West Tioga field Bakken discovery well in Williams County by Texacota, Inc., reached a total depth of 12,945 feet. Production of 26 barrels per day was reported from the interval 9,644 to 9,654 feet. It was officially reported completed on February 26.

The Clay field Madison pool discovery well in Renville County was completed by Macpet on March 23 after reaching a total depth of 4,850 feet. Production of 30 barrels per day was reported from the Madison Formation from the interval 4,748 to 4,754 feet.

The Land field Spearfish pool, discovered in Bottineau County by Smith-Fancher was completed on March 27 after

reaching a total depth of 3,300 feet. Production of 25 barrels per day was reported from the Spearfish Formation from a depth of 3,152 to 3,157 feet.

The Norwegian Creek field Madison pool in Stark County was discovered by Al-Aquitaine Exploration Limited. Well completion was reported on April 8. Production was 14 barrels per day from the Madison Formation in a zone 9,254 to 9,284 feet below the surface.

The Oakdale field Madison pool discovery by Wessely Energy Corp. was reported completed on May 1. It heralded a rash of Dunn County discoveries that continued into 1977. This first 1976 Dunn County discovery well was drilled to a depth of 11,930 feet. Production was reported at 125 barrels per day from the interval 9,816 to 9,840 feet in the Madison Formation.

The South Westhope field Madison pool discovered by Wiser Oil Co. in Bottineau County was reported completed on August 4. Crude production of 72 barrels per day was from the Madison Formation at a depth of 3,484 to 3,486 feet.

The Midway field Devonian pool discovered by Tiger Oil Co. in Williams County was reported completed on August 9 after drilling to a total depth of 12,944 feet. Production of 437 barrels per day was reported from the Devonian formation from a depth of 10,072 to 10,077 feet.

The Northstar field Madison pool discovery well in Burke County was completed after drilling to a total depth of 5,583 feet by Petroleum, Inc. of Texas on August 18. Production of 30 barrels per day of oil was reported from the Madison Formation from the interval 5,319 to 5,325 feet.

The MonDak field Madison discovery well in extreme western McKenzie County by Shell Oil Co. was reported completed on September 12. Production was 520 barrels per day from perforations in the Madison between depths of 8,916 to 9,166 feet.

The West Tioga field Devonian pool in Williams County was discovered by Texaco, Inc. The 13,000-foot-deep well was reported completed on September 15. Production of 61 barrels per day was reported from perforations between 10,153 to 10,155 feet deep.

The Halliday field Devonian pool in Dunn County was discovered by Alpar Resources. Well completion was reported on September 20. Production was 191 barrels per day from the Devonian formation from the interval 10,546 to 10,556 feet.

The Truro field Madison pool discovery by Wisser Oil Co. in Renville County was reported completed on September 21. Production of 68 barrels per day was reported from the Madison Formation from a depth of 4,720 to 4,745 feet.

The Bicentennial field Red River pool discovery well was completed by Farmland International Energy Co. on October 2. This McKenzie County discovery produced 488 barrels per day from the Red River from perforations at 12,972 to 12,984 feet and 12,991 to 13,003 feet.

The Grinnell field Madison pool discovery by Ashland Oil Co. was the last completion reported in 1976 on December 30. This Mountrail County discovery produced 113 barrels per day from the Madison Formation at depths of 8,184 to 8,188 and 8,193 to 8,199 feet.

NONMETALS

Clays.—Production of common clay and shale decreased 25% in quantity and 32% in value. Most of the clay was used in the production of lightweight aggregate and brick.

Gem Stones.—Agate, chalcedony, jasper, petrified wood, and similar semiprecious gem stones gathered by amateur collectors accounted for all State gem stone production.

Lime.—Quicklime was produced by American Crystal Sugar Co. in Pembina

County and by Minn-dak Farmers Co-op in Richland County. All production was for use in sugar refining.

Peat.—Peat Products Co. continued to produce reed-sedge peat in Bottineau County. Production was small because of the limited marketing area. The entire production was used for horticultural purposes.

Potash.—There has been no potash production in North Dakota to date. However, potash leasing and exploration activity during 1976 indicated the real possibility of the development of a potash solution mining-refining industry in northwestern North Dakota. Burlington Northern, Inc., and PPG Industries, Inc., drilled holes to explore the potash lying 6,000 to 12,000 feet below the surface. Cost of exploratory drilling to these depths was reported at between \$250,000 and \$500,000 per hole. The potash is a continuation of the beds being mined in Canada.

Salt.—Production of salt decreased 7% in quantity but increased 9% in value. Hardy Salt Co. continued to be the only producer. All production was in Williams County by solution mining methods. Most of the salt was used as stock feed, as an additive in oil well drilling solutions, and in water softening.

Sand and Gravel.—The quantity of sand and gravel produced in 1976 totaled 5.2 million short tons valued at \$8.3 million. Compared with that of 1975, production decreased 8% in quantity and increased 3% in value. Sand and gravel accounted for 3% of the value of all mineral commodities produced in the State. Average value was \$1.61 per ton, compared with \$1.44 per ton in 1975.

Table 6.—North Dakota: Construction sand and gravel sold or used by producers, in 1976

(Thousand short tons and thousand dollars)

	Use	Quantity	Value
Construction:			
Sand	-----	1,800	1,753
Gravel	-----	3,372	6,594
Total ¹	-----	5,171	8,345

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

Table 7.—North Dakota: Construction aggregate (blended sand and gravel) sold or used commercially by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential construction -----	1,138	2,606	1,060	3,033
Highway and bridge construction -----	W	W	5	17
Other construction (dams, waterworks, airports, etc.) -----	113	235	W	W
Concrete products (cement blocks, bricks, pipe, etc.) -----	96	217	120	361
Bituminous paving (asphalt and tar paving) -----	207	493	173	224
Roadbase and subbase -----	109	150	266	513
Fill -----	W	W	41	59
Other -----	--	--	4	5
Unprocessed:				
Roadbase and subbase -----	273	278	146	157
Fill -----	196	254	260	307
Total -----	2,132	¹4,232	2,075	4,676

W Withheld to avoid disclosing company proprietary data; included with "Nonresidential and residential construction."

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

Table 8.—North Dakota: Construction aggregate (blended sand and gravel) sold or used for publicly funded projects by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (including use in ready-mixed concrete):				
Nonresidential and residential construction -----	165	278	67	131
Highway and bridge construction -----	158	243	129	217
Other construction (dams, waterworks, airports, etc.) -----	W	W	4	14
Concrete products (cement blocks, bricks, pipe, etc.) -----	W	W	8	21
Bituminous paving (asphalt and tar paving) -----	564	962	415	685
Roadbase and subbase -----	841	752	1,221	1,562
Fill -----	W	W	22	42
Other -----	110	83	119	103
Unprocessed:				
Roadbase and subbase -----	1,400	1,394	897	765
Fill -----	266	189	213	131
Other -----	W	W	W	W
Total ¹ -----	3,505	3,901	3,096	3,669

W Withheld to avoid disclosing company proprietary data; included with "Highway and bridge construction."

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

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Clays: Hebron Brick Co -----	Hebron, N. Dak. 58638	Pit and brick plant.	Morton.
Coal:			
Baukol-Noonan, Inc -----	Noonan, N. Dak. 58765	Strip mines and plants.	Burke and Oliver.
Consolidation Coal Co ----	Box 200 Stanton, N. Dak. 58571	-----do-----	Mercer and Ward.
Knife River Coal Mining Co.	1915 N. Kavanev Dr. Bismarck, N. Dak. 58501	-----do-----	Bowman, Mercer, Oliver.
North American Coal Corp. (The Falkirk Mining Co. and The Coteau Properties Co.).	Kirkwood Office Tower Bismarck, N. Dak. 58501	-----do-----	Mercer and McLean.
Lime:			
American Crystal Sugar Co.	101 N. 3d St. Moorhead, Minn. 56506	Shaft kiln at beet sugar refinery.	Pembina.
Minn-dak Farmers Co-op --	Wahpeton, N. Dak. 58075	-----do-----	Richland.
Natural gas and petroleum, crude:			
Aminoil USA, Inc -----	Box 457 Tioga, N. Dak. 58852	Gas processing plant.	Williams.
Amoco Oil Co -----	Box 549 Mandan, N. Dak. 58554	Refinery -----	Morton.
Amoco Production Co ----	Box 591 Tulsa, Okla. 74102	Wells -----	Various.
Brownlie, Wallace, Arm- strong and Bander.	1660 Lincoln St., Suite 1420 Denver, Colo. 80264	Drilling and pro- ducing.	Do.
Cardinal Drilling Corp ----	Box 1077 Billings, Mont. 59103	-----do-----	Do.
Chandler & Associates, Inc.	1401 Denver Club Bldg. Denver, Colo. 80202	-----do-----	Do.
Chevron Oil Co -----	Box 599 Denver, Colo. 80202	-----do-----	Do.
Farmers Union Central Exchange (CENEX).	Box 126 Laurel, Mont. 59044	Refinery ----- Drilling and pro- ducing.	Yellowstone (Mont.). Various.
Gas Producing Enterprises.	Box 749 Denver, Colo. 80201	-----do-----	Do.
Gulf Oil Corp -----	Box 2619 Casper, Wyo. 82602	-----do-----	Do.
Hunt Industries -----	1401 Elm St. Dallas, Tex. 75202	Drilling and pro- ducing.	Williams.
Kerr-McGee Corp -----	Box 25861 Oklahoma City, Okla. 73125	Gas processing plant, drilling and producing. Refinery -----	McKenzie. Stark.
Northland Oil and Refining Co.	Box 1246 Dickinson, N. Dak. 58601	Drilling and pro- ducing.	Various.
Petroleum, Inc -----	Suite 800, 300 W. Douglas Wichita, Kans. 67202	-----do-----	Do.
Shell Oil Co -----	1710 Broadway Denver, Colo. 80202	-----do-----	Do.
Tenneco Oil Co -----	Box 2511 Houston, Tex. 77001	-----do-----	Do.
Texaco, Inc -----	Box 2100 Denver, Colo. 80201	-----do-----	Do.
Tiger Oil Co -----	Suite 1500, 5 Greenway Plaza Houston, Tex. 77046	-----do-----	Do.
True Oil Co -----	Box 2360 Casper, Wyo. 82601	-----do-----	Do.
Union Oil Co of California.	P.O. Box 7600 Los Angeles, Calif. 90054	-----do-----	Do.
Westland Oil Co -----	504 E. Central Minot, N. Dak. 58701	Refinery -----	Williams.
Salt: Hardy Salt Co -----	Box 728 Williston, N. Dak. 58801	Well and plant ----	Williams.
Sand and gravel:			
Dakota Sand & Gravel Co..	Box 22 Bismarck, N. Dak. 58501	Pit and plant ----	Burleigh.
Jamestown Sand & Gravel Co.	Ypsilanti, N. Dak. 58497	-----do-----	Stutsman.
Minot Sand & Gravel Co --	Box 116 Minot, N. Dak. 58701	-----do-----	Ward.
Northern Improvement Co..	Box 1254 Bismarck, N. Dak. 58501	-----do-----	Various.
Shenenne Sand & Gravel, Inc.	Box 848 New Rockford, N. Dak. 58856	-----do-----	Eddy and Foster.

The Mineral Industry of Ohio

By William S. Miska ¹

Ohio's mineral production was valued at \$1,435 million in 1976, an increase of \$80 million or 6% over that of the previous year. The value of the State's mineral output has set a new record high each year for 15 consecutive years. Nationally, Ohio continued to be an important producer of clays, bituminous coal, lime, salt, and stone.

Although increased output helped to boost the value of some commodities, much of the increase in total mineral production value during 1976 resulted from higher prices paid, particularly for natural gas, lime, and salt. Output and value of the principal commodities produced in 1976, compared with those of 1975, were as follows: Cement decreased 9% in output and 3% in value; clays increased 24% in output and value; coal decreased slightly in out-

put but increased 1% in value; lime increased 9% in output and 20% in value; natural gas increased 5% in output and 51% in value; petroleum increased 4% in output and 3% in value; salt decreased 1% in output but increased 21% in value; sand and gravel increased 5% in output and 12% in value; and stone decreased 8% in output and 1% in value.

Mineral production value in the State was distributed as follows: Coal, 54%; petroleum, 8%; lime, 8%; stone, 7%; natural gas, 6%; sand and gravel, 5%; portland and masonry cements, 5%; salt, 5%; and all remaining commodities combined, 2%. Belmont County was the leading mineral-producing county in the State.

¹ State Liaison Officer, Bureau of Mines, Bloomington, Ind.

Table 1.—Mineral production in Ohio ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry -----thousand short tons..	136	\$4,576	155	\$7,288
Portland -----do.....	2,364	70,268	2,130	65,656
Clays -----do.....	3,451	11,822	4,288	14,704
Coal (bituminous) -----do.....	46,770	766,875	46,582	773,699
Lime -----do.....	3,482	95,136	3,785	114,299
Natural gas -----million cubic feet..	84,960	59,982	88,891	90,491
Peat -----thousand short tons.....	4	99	3	121
Petroleum (crude) -----thousand 42-gallon barrels..	9,578	113,917	9,994	117,655
Salt -----thousand short tons.....	5,083	54,651	5,052	66,332
Sand and gravel -----do.....	37,195	68,552	38,876	76,730
Stone -----do.....	46,303	108,530	42,699	106,996
Value of items that cannot be disclosed:				
Abrasives, gem stones, and gypsum -----	XX	1,996	XX	1,925
Total -----	XX	1,356,454	XX	1,435,896
Total 1967 constant dollars -----	XX	536,749	XX	P 516,205

P Preliminary. XX Not applicable.

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

Table 2.—Value of mineral production in Ohio, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams	W	W	Stone.
Allen	\$2,056	\$1,898	Do.
Ashland	382	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	2,389	W	Coal, stone, sand and gravel.
Auglaize	W	W	Sand and gravel, stone, clays.
Belmont	251,055	W	Coal, sand and gravel, stone.
Brown	271	167	Stone, sand and gravel.
Butler	4,102	5,037	Sand and gravel.
Carroll	W	W	Coal, stone, sand and gravel, clays.
Champaign	W	W	Sand and gravel, peat.
Clark	W	W	Sand and gravel, stone.
Clermont	W	W	Do.
Clinton	W	983	Stone, sand and gravel.
Columbiana	13,547	W	Coal, sand and gravel, clays.
Coshocton	W	W	Coal, sand and gravel, stone, clays.
Crawford	W	W	Stone.
Cuyahoga	19,279	21,973	Salt, lime, clays, peat.
Darke	W	W	Sand and gravel, clays.
Defiance	W	2	Sand and gravel.
Delaware	2,907	2,045	Stone, clays.
Erie	W	W	Lime, stone, sand and gravel.
Fairfield	627	W	Sand and gravel.
Fayette	W	W	Stone.
Franklin	W	W	Sand and gravel, stone, clays.
Gallia	W	W	Coal, sand and gravel.
Geauga	W	W	Sand and gravel, stone.
Greene	W	22,689	Cement, stone, sand and gravel, clays.
Guernsey	W	W	Coal, stone.
Hamilton	6,765	6,783	Sand and gravel.
Hancock	W	W	Stone, lime.
Hardin	W	W	Stone.
Harrison	W	W	Coal, stone, clays.
Henry	W	203	Sand and gravel, clays.
Highland	1,244	W	Stone, sand and gravel.
Hocking	W	W	Coal, sand and gravel, clays.
Holmes	8,763	8,637	Coal, stone, clays, sand and gravel.
Huron	W	W	Sand and gravel, stone.
Jackson	13,702	18,521	Coal, clays, stone, sand and gravel.
Jefferson	75,623	W	Coal, clays.
Knox	W	W	Stone, sand and gravel.
Lake	W	W	Lime, salt, sand and gravel.
Lawrence	W	10,504	Cement, coal, clays, sand and gravel, stone.
Licking	W	W	Sand and gravel, clays.
Logan	990	939	Stone, sand and gravel.
Lorain	W	W	Lime, stone, sand and gravel, grindstones.
Lucas	W	W	Cement, stone, sand and gravel, clays.
Madison	W	W	Stone, sand and gravel.
Mahoning	W	W	Stone, coal, clays, sand and gravel, peat.
Marion	2,254	2,138	Stone, sand and gravel, clays.
Medina	W	W	Sand and gravel, clays, stone.
Meigs	W	W	Coal, sand and gravel.
Mercer	W	W	Stone.
Miami	4,023	4,708	Stone, sand and gravel.
Monroe	W	W	Coal, stone.
Montgomery	W	W	Sand and gravel, stone.
Morgan	W	W	Coal, sand and gravel, stone.
Morrow	140	164	Sand and gravel.
Muskingum	W	W	Coal, cement, stone, clays, sand and gravel.
Noble	W	W	Coal, stone, clays.
Ottawa	W	W	Stone, lime, gypsum.
Paulding	W	W	Cement, stone, clays.
Perry	86,293	33,927	Coal, stone, clays.
Pickaway	W	W	Sand and gravel, stone.
Pike	W	W	Do.
Portage	6,593	6,491	Sand and gravel.
Preble	W	W	Sand and gravel, stone.
Putnam	533	W	Stone, clays.
Richland	W	W	Sand and gravel, clays, peat.
Ross	W	W	Sand and gravel, stone.
Sandusky	W	61,388	Lime, stone.
Scioto	W	W	Stone, clays, sand and gravel, coal.
Seneca	W	W	Lime, stone, clays.
Shelby	734	W	Stone, sand and gravel.
Stark	19,550	15,609	Coal, cement, sand and gravel, clays, stone.
Summit	W	W	Salt, sand and gravel, stone.
Trumbull	W	W	Sand and gravel, stone.
Tuscarawas	W	W	Coal, sand and gravel, clays, stone.

See footnotes at end of table.

Table 2.—Value of mineral production in Ohio, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Union -----	W	W	Stone.
Van Wert -----	\$1,222	W	Do.
Vinton -----	W	W	Coal, clays.
Warren -----	W	W	Sand and gravel, stone.
Washington -----	1,745	W	Sand and gravel, coal, stone.
Wayne -----	21,217	\$27,056	Salt, sand and gravel, coal, stone, clays.
Williams -----	564	662	Sand and gravel, peat.
Wood -----	2,698	2,708	Stone.
Wyandot -----	W	W	Stone, lime, sand and gravel, peat, clays.
Undistributed ² -----	855,189	1,180,659	
Total ³ -----	1,856,454	1,485,896	

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

¹ Fulton County is not listed because no production was reported. County data for natural gas and petroleum values are not available; included with "Undistributed."

² Includes natural gas, petroleum, 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

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands ..	4,726.0	4,780.0	+0.1
Unemployment ----- do ..	480.0	369.0	-14.2
Employment (nonagricultural):			
Mining ----- do ..	26.8	28.3	+5.6
Manufacturing ----- do ..	1,267.5	1,293.5	+2.1
Contract construction ----- do ..	154.9	155.8	+6
Transportation and public utilities ----- do ..	213.2	212.3	-4
Wholesale and retail trade ----- do ..	868.0	892.2	+2.8
Finance, insurance, real estate ----- do ..	173.1	176.6	+2.0
Services ----- do ..	686.8	709.3	+3.4
Government ----- do ..	626.4	631.9	+0.9
Total nonagricultural employment ----- do ..	4,016.2	4,099.8	+2.1
Personal income:			
Total ----- millions ..	\$61,981	\$68,541	+10.6
Per capita ----- do ..	\$5,774	\$6,412	+11.0
Construction activity:			
Number of private and public residential units authorized ..	39,080	48,660	+24.5
Value of nonresidential construction ----- millions ..	\$689.1	\$917.9	+33.2
Value of State road contract awards ----- do ..	\$188.5	\$200.0	+6.1
Shipments of portland and masonry cement to and within the State ----- thousand short tons ..	3,027	2,992	-1.2
Mineral production value:			
Total crude mineral value ----- millions ..	\$1,856.5	\$1,485.9	+5.9
Value per capita, resident population ----- do ..	\$127	\$134	+5.5
Value per square mile ----- do ..	\$32,906	\$34,838	+5.9

^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.

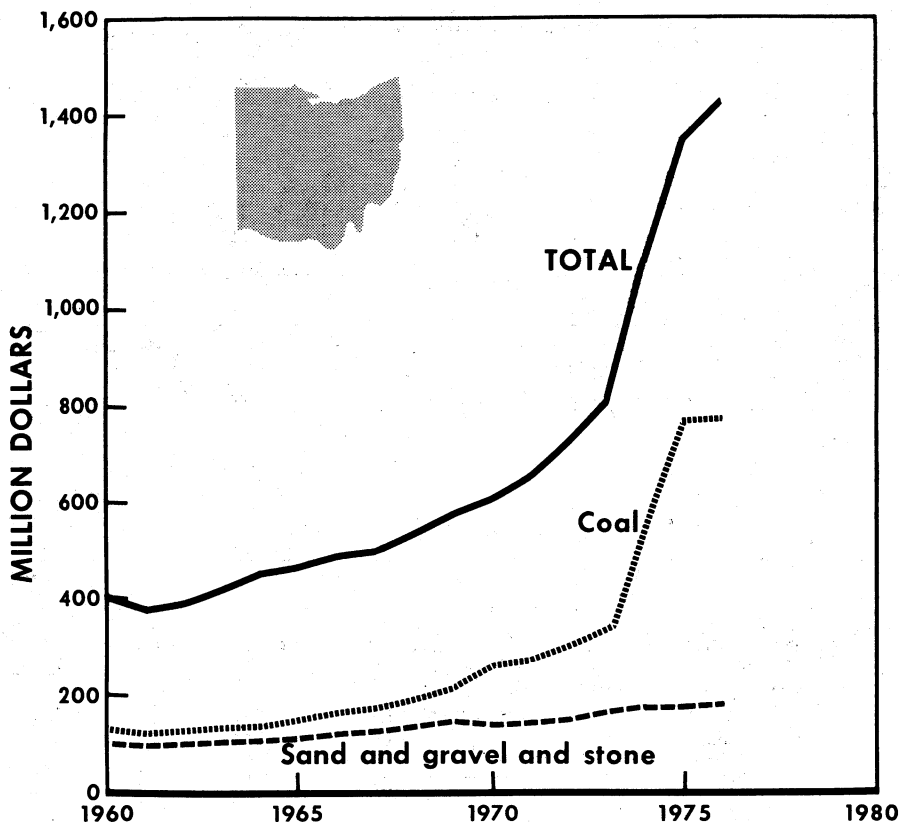


Figure 1.—Value of coal, sand and gravel, and stone, and total value of mineral production in Ohio.

Employment and Injuries.—According to the Federal Mine Enforcement and Safety Administration, employment in Ohio's mineral industries, excluding petroleum and natural gas, totaled 24,439 persons during 1976. Coal industry employment ranked first with 66% of the total, followed by sand and gravel, 9%; limestone and dolomite, 8%; lime, 5%; cement, 4%; clays, 3%; sandstone, 3%; and all remaining industries combined, 2%.

Injuries at coal mining operations included 7 fatalities, 699 nonfatal disabling injuries, and 414 nondisabling injuries. Nonmetallic mineral producers reported 3 fatalities, 239 nonfatal disabling injuries, and 81 nondisabling injuries.

During 1976, Federal mine inspectors from the Mining Enforcement and Safety Administration conducted 3,948 inspections and investigations at Ohio coal mines, as follows: 867 regular health and safety inspections; 1,194 spot inspections; 751 violation follow-up inspections; and 1,136 other inspections and investigations, for such matters as accidents, accident prevention, electrical, technical, and complaints. Federal metal- and nonmetal-mine inspectors performed a total of 652 regular inspections and 665 spot inspections at clay, cement, stone, sand and gravel, peat, gypsum, and salt operations.

State mine inspectors from the Ohio Division of Mines conducted 3,433 inspec-

tions at coal and nonmetallic operations and spent a total of 680 man-days witnessing the plugging of abandoned oil and gas wells that had been drilled through coal-bearing formations.

Two Joseph A. Holmes Safety Association awards were presented to Ohio miners for acts of heroism. The association's Medal of Honor was awarded posthumously to Steve E. Hornbeck for giving his life to save a coworker, Larry Briggs, from a roof fall by throwing him against the rib at the Powhatan No. 1 Mine, North American Coal Corp., Powhatan Point, on December 13, 1976. A Certificate of Honor was awarded to Robert Arndt for giving warning and directing three men to safety while exposing himself to impending danger of premature detonation of a primary quarry blast set off by lightning at the Pfizer, Inc., lime plant, Gibsonburg, on August 13, 1976.

Two Ohio mines were among the six winners of the 1976 Sentinels of Safety Awards Program, cosponsored by the Mining Enforcement and Safety Administration and the American Mining Congress. Consolidation Coal Co.'s Rose Valley No. 6 mine won the competition for underground coal mines by having 535,891 man-hours worked without a disabling injury. Columbia Cement Corp.'s Jonathan mine, a limestone operation, won in the underground nonmetal mine category for 153,874 man-hours worked without a disabling injury. Each of the winning operations received the Sentinels of Safety trophy and flag, and each official and employee received a Certificate of Accomplishment in Safety.

Diamond-Kosmos Cement Div., The Flintkote Co., received a Safety Trophy Reward from the Portland Cement Association for operating during 1976 without a lost-time accident.

Certificates of Achievement in Safety were awarded by the National Sand and Gravel Association to the following in the association's annual safety competition for operating in 1976 without lost-time accidents: Class B (plants producing 550,000 to 1,499,000 tons)—Dravo Corp., Ohio Gravel Div., Newton plant; and Standard Slag Co., Shalersville plant; Class C (225,000 to 549,000 tons)—Western Materials Co., Wapakoneta plant; American Materials Corp., Harrison plant; American Aggregates Corp.—Dayton North and Lockbourne

plants; and Dravo Corp., Ohio Gravel Div., Camp Dennison, Morrow, Ross, and Fairfield plants; Class D (170,000 to 224,999 tons)—Standard Slag Co., Haverhill and Cutlip plants; and American Aggregates Corp., Urbana, Urbana 215, Xenia, and Springfield plants; Class E (60,000 to 169,000 tons)—American Aggregates Corp., Newark plant; Young's Sand & Gravel Co., Loudonville plant; Brewer & Brewer Sons, Inc., Chillicothe plant; and Sidney Sand & Gravel Co., Sidney plant; and Class F (less than 60,000 tons)—Rubber City Sand & Gravel Co., Akron plant.

A special certificate was awarded to American Aggregates Corp. for a 5-year accident-free record at its Harrison plant; to Brewer & Brewer Sons, Inc., for a 41-year accident-free record at its Chillicothe plant; and to Rubber City Sand & Gravel Co. for a 5-year accident-free record at its Akron plant.

A Safety Award was presented to National Lime & Stone Co.'s Buckland quarry by the National Crushed Stone Association for an injury-free year in 1976.

The National Limestone Institute Inc. awarded Special Safety Certificates to France Stone Co.'s Paulding quarry and Silica quarry, for 5 consecutive years without a disabling injury; and to France Stone Co.'s Flat Rock quarry, for 4 consecutive years without a disabling injury.

Legislation and Government Programs.—The Ohio General Assembly enacted the following laws that directly or indirectly affect the mineral industry:

1. Amended House Bill 28 places 75% of severance tax revenues into an Unreclaimed Lands Fund, which the act creates for reclaiming "orphan" mined lands and controlling mine drainage, and 25% into the Oil and Gas Well Plugging Fund for plugging abandoned oil and gas wells, undertaking associated land restoration activities, and injecting oil and gas production wastes into abandoned wells; the bill also requires the Board on Unreclaimed Strip Mined Lands to recommend reclamation projects, and the Chief of the Division of Oil and Gas to recommend plugging, injection, and restoration projects for expenditure approval by the Controlling Board.

2. Amended Substitute House Bill 579, which became effective December 21, 1975, limits the fuel costs that privately-owned electric companies may pass through to customers, without a hearing; establishes a

limited rate hearing process to review fuel-cost-adjustment clauses every 6 months; requires companies to report fuel costs and fuel procurement practices to the Public Utilities Commission of Ohio (PUCO); requires PUCO to issue a rule setting up incentives for the implementation and use of efficient fuel procurement and utilization practices by electric companies; permits PUCO to authorize electric companies to issue stocks and bonds with a term exceeding 1 year, for the purpose of acquiring a fuel-producing facility; and requires captive fuel producers to satisfy the needs of their parent electric companies, or any Ohio affiliates of such companies, before selling their output to others.

3. Amended Substitute Senate Bill 404 requires a liquid disposal permit from the Ohio Environmental Protection Agency rather than from the Division of Oil and Gas, before anyone may use a well for the injection of sewage, industrial waste, or other wastes; gives existing permit holders 60 days to apply for a new permit; increases penalties for violating liquid disposal permit requirements; exempts from water pollution discharge permit requirements the injection of materials into wells for brine production purposes; and specifies that all underground waters, regardless of depth, are "waters of the State" into which the discharge of wastes is prohibited without a permit.

4. Amended House Bill 1297, enacted effective January 11, 1977, requires PUCO to make public safety inspections of all gas and natural gas pipelines, regardless of the nature of the entity that owns, operates, or controls the pipelines; and specifies that PUCO is empowered to issue any pertinent rule or order that it finds necessary to protect the public safety.

5. Amended Substitute House Bill 857, effective January 25, 1977, conforms Ohio's Mine Health and Safety Laws with the Federal laws and regulations governing mine inspections, ventilation, escapeways, sanitary facilities, rock dusting, underground roof control, self-rescue devices, storage of lubricants, mobile equipment, track, locomotives, hoists, belts, and fire-fighting, communication, and first-aid equipment; makes certain provisions of the Mine Health and Safety Laws apply only to underground mines; requires underground coal mine superintendents ap-

pointed after January 1, 1977, to pass an examination indicating their familiarity with the State mining laws; authorizes an increase from 26 to 30 in the number of inspectors appointed by the Chief of the Division of Mines; establishes a new inspector classification and pay range; authorizes the Chief to issue reasonable orders to mine operators requiring compliance with Mine Health and Safety Laws; prohibits violation of the Chief's rules and orders, and classifies all mine health and safety offenses as minor misdemeanors; and repeals the laws governing stables, stablemen, and use of mules or other livestock in mines.

The Ohio Department of Taxation reported severance tax collections for the fiscal year ending June 30, 1976, totaling \$3,925,790 compared with \$3,892,815 collected in fiscal 1975. Severance tax collections in fiscal 1976 were as follows: Coal, \$1,877,869; natural gas, \$806,847; limestone, \$352,427; oil, \$255,565; gravel, \$217,781; salt, \$191,455; sand, \$159,505; and dolomite, \$64,340. The severance tax rate is 4 cents per ton of coal, 3 cents per barrel of oil, 1 cent per 1,000 cubic feet of natural gas, and 1 cent per ton of limestone, dolomite, sand, or gravel.

The Ohio Division of Reclamation licensed 206 operators and issued 426 permits under the coal strip-mining regulation program. A total of 26,274 acres was bonded by coal operators during 1976. About 13,000 acres was affected by mining operations. The division approved grading work for partial release of bond on 15,892 acres, and the remaining bond was released for completion of planting work on 14,300 acres.

The Ohio Division of Reclamation continued implementation of the surface-mining regulation program begun in July 1975 for industrial minerals. Surface-mining operations for minerals other than coal in 50 of Ohio's 88 counties were phased into the program by yearend 1976. All industrial mineral operations in the remaining counties are scheduled to be under regulation by mid-1977. The division issued 250 permits to industrial mineral operators between July 1, 1975, and December 31, 1976. The permits expire 10 years after the date of issuance. Although the acreage permitted totaled 29,823, only 2,575 acres was bonded by operators for mining activities through yearend 1976.

The Ohio Division of Geological Survey published Information Circular 44, "Coal Production in Ohio—1800-1974"; Geological Notes 3, "Potential Natural Gas Resources in the Devonian Shales in Ohio"; and Geological Notes 4, "Coal Resources of a Portion of the Pawpaw Creek Watershed, Monroe, Noble, and Washington Counties." Among other publications released by the Ohio Division of Geological Survey were Information Circular 45, "Place Names Directory: Northeast Ohio" and Information Circular 46, "Subsurface Information Catalog—1968-1974."

The Ohio Energy and Resource Development Agency (OERDA) approved seven projects during its first year of operation ending June 30, 1976. Most of the projects were jointly funded by OERDA, Federal agencies, and other governmental and

private sources. The projects are as follows: Natural gas stimulation by massive hydraulic fracturing, shale gas stimulation, gas and oil exploration in the Cambrian and Ordovician formations, a statewide energy conservation program, an energy seminar for science teachers, low and medium Btu gas from coal, and shale characterization.

The Federal Bureau of Mines awarded research contracts to the Agricultural Research Service and the Ohio Agricultural Research and Development Center to study the effects of coal strip-mining upon the hydrology and water quality of areas to be mined in Ohio. The study, begun in January 1976, will continue through January 1981 and is expected to provide information needed for designing sediment dams, erosion control structures, and evaluating surface slopes and slope lengths.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Production of bituminous coal in 1976 was 46,582,000 tons valued at \$773,699,000. Coal continued to be the State's principal mineral commodity, accounting for 54% of the total value of mineral production. Output was 188,000 tons less than that of 1975. The value of output rose 1%. Belmont County, with 7 underground coal mines and 36 surface coal mines, was the leading producer with 14,043,000 tons, followed by Harrison County with 6,854,000 tons. Together, these two adjoining counties accounted for 45% of Ohio's coal production. Within the State, surface-mining accounted for 64% of the coal produced, and underground mining, 36%.

Ohio is the leading consumer of the Nation's coal output. Coal consumption in 1976 was 70,964,000 tons, an increase of 4% or 2.9 million tons compared with that of 1975. Of the total consumed, 50% came from mines in the State; 34%, from West Virginia, Virginia, and eastern Kentucky; 9%, from Pennsylvania; 5%, from Wyoming, Utah, and Colorado; and most of the remaining 2%, from western Kentucky. Electric utilities used 71% of the coal consumed in the State; coke and gas plants used 18%; and most of the remaining 11% was used by industrial plants. Despite consuming more coal than it produces, about 24% of Ohio's coal production was shipped to out-of-State customers in Michigan, Tennessee, Pennsylvania, Wisconsin, and West Virginia.

Table 4.—Ohio: Bituminous coal production in 1976, by type of mine and county

County	Number of mines		Production (thousand short tons)			Value (thou- sands)
	Under- ground	Surface	Under- ground	Surface	Total	
Athens -----	--	4	--	111	111	\$1,758
Belmont -----	7	36	6,925	7,118	14,043	245,069
Carroll -----	--	9	--	268	268	4,127
Columbiana -----	2	23	W	W	W	16,131
Coshocton -----	2	17	W	W	W	33,690
Gallia -----	--	5	--	428	428	6,821
Guernsey -----	1	7	W	679	W	11,573
Harrison -----	5	20	2,979	3,875	6,854	119,739
Hocking -----	--	10	--	710	710	9,225
Holmes -----	--	4	--	555	555	7,716
Jackson -----	1	20	W	W	W	15,627
Jefferson -----	2	29	W	W	W	53,776
Lawrence -----	--	5	--	206	206	2,668
Mahoning -----	--	8	--	290	290	4,943
Meigs -----	2	--	W	--	W	W
Monroe -----	2	--	W	--	W	W
Morgan -----	--	1	--	W	W	W
Muskingum -----	2	14	W	W	W	78,748
Noble -----	--	3	--	323	323	5,142
Perry -----	3	7	W	W	W	29,305
Scioto -----	--	1	--	W	W	W
Stark -----	--	12	--	410	410	6,136
Tuscarawas -----	--	16	--	1,307	1,307	21,431
Vinton -----	2	13	W	W	W	35,061
Washington -----	--	1	--	W	W	W
Wayne -----	--	1	--	W	W	W
Undistributed -----	--	--	6,722	13,676	21,077	65,013
Total -----	31	266	16,626	29,956	46,582	778,699

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

According to the Lake Carrier's Association, the Ohio ports of Conneaut, Ashtabula, Lorain, Sandusky, and Toledo on Lake Erie accounted for 85% of the 37.5 million tons of bituminous coal loaded for shipment on the Great Lakes during 1976. Of the 31.7 million tons of bituminous coal shipped from Ohio ports during 1976, 14.4 million tons was loaded at Toledo; 6.5 million tons, at Conneaut; 4.9 million tons, at Sandusky; 4.8 million tons, at Ashtabula; and 1.1 million tons, at Lorain. Approximately one-half of the coal was shipped to Canadian ports and the remainder to other U.S. ports on the Great Lakes. Nearly 5,000 tons of anthracite coal was shipped on the Great Lakes during 1976, all of it which loaded at Toledo. Expansion of the Conneaut dock from an annual capacity of 9 million tons to 13.5 million tons was announced by Bessemer & Lake Erie Railroad Co., which hauls coal to the dock, and Pittsburgh & Conneaut Dock Co., both subsidiaries of United States Steel Corp. The expansion project is expected to be completed by 1978.

Panhandle Eastern Pipe Line Co. announced an expansion program that will

double the output of its Youghiogheny and Ohio Coal Co. underground mines to 4 million tons annually. The Nelms No. 1 mine will be phased out as the 1-million-ton-per-year Cadiz Portal goes into production during 1977. Nelms No. 2 mine is scheduled to increase production from 750,000 tons annually to 1.2 million tons, in July 1978. Production at the Allison mine will increase to 1.8 million tons annually at the same time.

Early in the year, Cravat Coal Co. was acquired by Cargill, Inc., a Minnesota-based grain-exporting firm. The coal firm, a medium-size producer, operated 25 small surface mines in several counties at the time of acquisition.

Saginaw Mining Co., a subsidiary of Oglebay Norton Co., reported progress in increasing output at its underground Saginaw mine to 1 million tons of coal per year by 1979. Output during 1976 reached 750,000 tons, a 35% increase over that of 1975.

Filtrol Corp. acquired a coal property near Roseville in Muskingum County. Coal strip-mined at the site will be used at the firm's Zanesville cement plant and sold to

other Ohio users. Output is expected to reach 300,000 tons per year by 1979.

The Federal Energy Research and Development Agency (ERDA) agreed to support planning and engineering design work for a coal gasification demonstration plant proposed by a consortium of nine firms headed by Continental Oil Co. and Consolidated Gas Supply Corp. If built, the plant is expected to cost about \$250 million. It would be located near Caldwell in Noble County, and produce about 60 million cubic feet of synthetic natural gas per day. Coal requirements would average 3,900 tons per day.

Coke.—Coke production totaled 8,430,000 tons valued at \$684.1 million, \$81.15 per ton. About 12,192,000 tons of coal was carbonized in the coking process. The value of the coal carbonized was \$498,613,000. Most of the coke was used to produce iron and steel and for other metallurgical purposes. The coking process also yielded 694,000 tons of coke breeze which was used at agglomeration plants and for other industrial purposes.

In September, Diamond Shamrock Corp. sold its coke plant in Lake County to Erie Coke & Chemical Co., a subsidiary of Mercier Corp. The coke plant had been part of a soda ash chemical plant which was permanently shut down later in the year. The new owners operate the plant to produce coke for foundry use.

Republic Steel Corp's new \$35 million No. 1 coke battery at Cleveland was completed in early autumn and was brought up to operating temperature ready to receive coal on October 11. However, actions taken by a group of church, civic, and environmental organizations delayed the start of coking operations until the second week of February 1977. Startup operations were approved by State and Federal pollution control authorities on condition that the firm install adequate pollution controls by September 1978.

In response to dwindling energy supplies, some iron and steel producers with coking facilities began taking advantage of gases produced as byproducts in coke ovens to replace natural gas. Armco Steel Corp's new \$175 million coke-oven complex in Middletown is designed to provide the equivalent of 16 million cubic feet per day of natural gas to fuel various steelmaking furnaces.

Peat.—Six companies reported peat production in six counties, including Champaign, Cuyahoga, Mahoning, Richland, Williams, and Wyandot. Sales of peat totaled 2,998 tons valued at \$120,800, a decrease of 33% in quantity but an increase of 22% in value compared with that of 1975. The average value of peat increased from \$22.35 per ton in 1975 to \$40.30 per ton in 1976. The types of peat produced included humus and moss peat. Four firms sold peat as mined; three firms shredded peat; and one firm prepared kiln-dried peat and marketed peat in package form. Most of the peat was used principally in bulk form for soil conditioning.

Petroleum and Natural Gas.—Production of crude petroleum from 15,453 wells² was 9,994,000 barrels, 4.3% more than produced in 1975. Total value of crude production was \$117,655,000, an increase of 3.3% over that of the previous year. The average value was \$11.77 per barrel, a 12-cent-per-barrel decrease from that of 1975.

Natural gas production increased 5% in quantity and 51% in value. The 88,891 million cubic feet of natural gas produced in Ohio during 1976 was valued at \$90.5 million. The output accounted for 9% of the 1,005,927 million cubic feet of gas used by Ohio consumers. Natural gas consumption in the State was distributed as follows: Residential, 44%; industrial, 37%; commercial, 17%; and electric utilities, natural gas pipeline companies, and other consumers, 2%. Natural gas consumption in 1976 was 5% greater than that of 1975.

Reserves at yearend 1976 were 1,350,581 million cubic feet of natural gas and 125 million barrels of crude petroleum, according to the American Gas Association and the American Petroleum Institute. Compared with that at yearend 1975, reserves of natural gas decreased 3,429 million cubic feet, and proved reserves of crude petroleum increased 4 million barrels. Of the natural gas reserves at yearend 1976, 324,631 million cubic feet was held in underground storage reservoirs.

According to the Ohio Division of Oil and Gas, the number of new wells drilled for oil and gas during 1976 totaled 1,936, an increase of 59% over that of the previous year and the highest number of wells drilled in Ohio since 1964. Total footage

² World Oil. Feb. 15, 1977, p. 106.

drilled increased 57% to 7,675,000. The average depth per well decreased about 50 feet per well, from 4,015 feet in 1975 to 3,964 feet in 1976. Of the 1,936 wells drilled during 1976, 162 were classified by the Ohio Division of Oil and Gas as exploratory, and 1,774, as proved field wells. Rotary tools were used to drill 1,224 wells or 63% of the

total, and cable tools drilled 712 or 37%. The drilling success ratio for all wells drilled was 91.5%, with 213 wells producing oil; 816, gas; and 743, producing a combination of both oil and gas. Dry holes totaled 164 and accounted for 7% of the total footage drilled.

Table 5.—Ohio: Oil and gas well drilling in 1976, by county

County	Gas wells	Oil wells	Combina- tion wells ¹	Dry holes	Total		Percent produc- tive
					Wells	Footage	
Ashland	1	6	2	1	10	11,793	90.0
Ashtabula	14	--	20	1	35	122,351	97.1
Athens	--	4	--	5	9	7,298	44.4
Carroll	5	77	14	--	96	539,991	100.0
Clermont	--	--	--	1	1	1,581	--
Columbiana	3	--	1	3	7	42,689	57.1
Coshocton	30	22	87	11	150	550,265	92.7
Cuyahoga	3	--	--	--	3	5,899	100.0
Defiance	4	1	--	5	10	18,440	50.0
Erie	2	--	--	--	2	3,115	100.0
Fairfield	2	2	1	1	6	14,574	83.3
Gallia	6	--	5	1	12	20,540	91.7
Geauga	3	--	1	3	7	21,144	57.1
Guernsey	15	1	39	6	61	309,830	90.2
Harrison	12	1	3	3	19	107,362	84.2
Henry	9	--	--	3	12	19,171	75.0
Hocking	9	11	36	5	61	186,323	91.8
Holmes	17	2	38	7	64	198,088	89.1
Huron	--	--	--	1	1	3,738	--
Jefferson	--	--	--	1	1	1,655	--
Knox	8	11	48	4	71	202,186	94.4
Lake	2	--	3	--	5	15,653	100.0
Lawrence	1	--	--	--	1	2,730	100.0
Licking	4	14	32	4	54	146,277	92.6
Lorain	3	--	--	--	3	5,550	100.0
Mahoning	150	5	11	11	177	896,318	93.8
Marion	--	--	--	1	1	2,823	--
Medina	3	--	6	--	9	31,991	100.0
Meigs	19	--	13	3	35	76,605	91.4
Mercer	1	--	--	--	1	1,150	100.0
Monroe	2	1	--	--	3	6,530	100.0
Morgan	16	4	8	5	33	104,951	84.8
Morrow	--	--	--	9	9	27,101	--
Muskingum	67	15	69	18	169	676,635	89.3
Noble	93	1	14	6	114	643,284	94.7
Faulding	5	--	--	4	9	14,820	55.6
Ferry	21	7	66	7	101	329,511	93.1
Portage	49	1	77	9	135	501,118	93.3
Richland	4	1	1	5	11	26,502	54.5
Shelby	8	--	1	--	6	8,003	100.0
Stark	5	8	14	1	31	141,777	96.8
Summit	5	--	16	1	22	84,356	95.5
Trumbull	95	--	19	2	116	519,894	93.3
Tuscarawas	97	9	46	3	155	765,040	98.1
Washington	14	8	42	2	66	154,998	97.0
Wayne	9	1	10	11	31	102,254	64.5
Wood	--	1	--	--	1	1,220	100.0
Total	816	213	743	164	1,936	7,675,114	91.5

¹ Produces both oil and gas.

Source: Ohio Division of Oil and Gas.

Silurian Age Clinton and Medina sandstone were the principal drilling targets, accounting for 84.2% or 1,630 wells drilled, and 94.1% of the total footage. Of the 1,630 wells drilled into the Clinton and Medina sandstone, 1,534 were productive and 96 were dry holes.

A total of 47 of Ohio's 88 counties reported oil and gas drilling activity during 1976, and 42 of the 47 counties reported finding oil or gas. Eight counties reported more than 100 wells drilled during the year. Mahoning County with 177 wells drilled was the most active county, closely followed by Muskingum County with 169 wells, Tuscarawas County with 155 wells, and Coshoc-ton County with 150 wells. Other counties exceeding 100 wells were Portage, Trumbull, Noble, and Perry.

The total crude oil distillation capacity of Ohio's six operating petroleum refineries as of January 1, 1977, was 570,000 barrels per day, 600 barrels more than on January 1, 1976. The refineries and their capacities at yearend are as follows, in barrels per calendar day: Ashland Oil, Inc., 64,000 at Canton, Stark County; Gulf Oil Corp., 42,700 at Cleves, Hamilton County, and 50,300 at Toledo, Lucas County; Standard Oil Co. of Ohio, 168,000 at Lima, Allen County, and 120,000 in Toledo, Lucas County; and Sun Oil Co., 125,000 at Toledo, Lucas County.

Crude oil input to Ohio's refineries plus two asphalt-processing plants operated by Chevron Asphalt Co. in Hamilton County and Standard Oil Co. of Ohio in Cuyahoga County totaled 192,615,000 barrels, compared with 183,583,000 barrels in 1975. Foreign crude oil shipments to Ohio refineries increased from 29% of the total input in 1975 to 34% in 1976.

NONMETALS

Abrasives.—Cleveland Quarries Co. produced grindstones as a byproduct of its sandstone quarrying operations at Amherst in Lorain County. Output of grindstones decreased in quantity but increased in value compared with the previous year.

Ohio is a significant producer of metallic abrasives, with five companies operating six plants in Butler, Cuyahoga, Lucas, and Richland Counties. The quantity of metallic abrasives sold or used in 1976 was considerably below that of 1975.

Cement.—Portland cement was produced at seven plants, four of which also produced masonry cement. Output of portland cement decreased 4% to 2,189,725 tons, and shipments decreased 10% to 2,129,722 tons. Value of shipments declined 7% to \$65,655,524. Stocks of portland cement at yearend 1976 were 212,405 tons, 8% more than at yearend 1975. The average mill value of portland cement increased \$1.11 per ton to \$30.83.

Type I (general construction use) and Type II (moderately low-heat and moderate degree of resistance to sulfate attack) comprised 98% of the portland cement shipped; all others combined comprised only 2%.

Disposition of portland cement shipped by Ohio manufacturers was as follows: 68% to ready-mix concrete producers; 19% to concrete product manufacturers for concrete blocks, concrete pipes, precast prestressed concrete, and other concrete products; 7% to building-material dealers; 5% to highway contractors; and the remaining 1% to other contractors and miscellaneous customers. Apparent consumption of portland cement in Ohio during 1976 was 2,840,000 tons, about 2% less than that of 1975.

Masonry cement production increased 15% to 156,927 tons. Shipments increased 14% to 155,141 tons, and value of ship-

Table 6.—Ohio: Portland cement salient statistics
(Short tons)

	1975	1976
Number of active plants.....	8	7
Production	2,292,414	2,189,725
Shipments from mills:		
Quantity	2,363,695	2,129,722
Value	\$70,268,466	\$65,655,524
Stocks at mills, Dec. 31.....	196,644	212,405

Table 7.—Ohio: Masonry cement salient statistics
(Short tons)

	1975	1976
Number of active plants.....	5	4
Production	136,927	156,927
Shipments from mills:		
Quantity	136,272	155,141
Value	\$4,575,629	\$7,287,542
Stocks at mills, Dec. 31.....	12,208	14,626

ments increased 59% to \$7,287,542. Stocks at yearend 1976 were 14,626 tons, 20% greater than that at yearend 1975. The average mill value of masonry cement increased \$13.39 per ton to \$46.97, an increase of 40%. Apparent consumption of masonry cement in Ohio during 1976 was 188,000 tons, an increase of 5% over consumption in 1975.

PPG Industries, Inc., shut down its cement plant at Barberton in Summit County during the second quarter of the year and completed shipments of cement stocks on-hand during the third quarter. Stone for the plant was obtained from the firm's underground limestone mine which was abandoned earlier in the year for economic reasons.

At midyear, The Flintkote Co. shut down its cement kiln at the Middlebranch plant in Stark County. The kiln had been operating under an air pollution control variance which expired on July 1. The plant continued as a grinding and distribution operation until late in the year, when the entire plant was permanently shut down.

In September, Gulf+Western Industries, Inc., acquired Marquette Cement Manufacturing Co., including Marquette's cement plant in Lawrence County.

Late in the year, Southwestern Portland Cement Co. acquired additional limestone and clay reserves and finished cement storage facilities for its Fairborn plant in Greene County. The reserves and facilities were purchased from Universal Atlas Cement Div., United States Steel Corp., which shut down its cement plant at Fairborn during the latter part of 1975.

Filtrol Corp. completed construction of a new clinker cooler dust collector at its Zanesville plant.

Clays.—Combined clay and shale production totaled 4,288,000 tons valued at \$14,704,000, an increase of 24% in both quantity and value over that of the previous year. Output consisted of 3,588,000 tons of common clay and shale valued at \$9,374,000, and 700,000 tons of fire clay valued at \$5,330,000. Average unit value per ton of common clay and shale increased 35 cents to \$2.61, and that of fire clay increased 29 cents per ton to \$7.61. Ohio ranked first in the Nation in the value of common clay and shale produced, and sec-

ond after Texas in the quantity produced. Among the States that produced fire clay, Ohio ranked third in quantity and value, after Pennsylvania and Missouri.

Clay and shale was produced by 67 companies from 96 mines in 35 counties. Forty-eight companies with 70 mines produced common clay and shale, and 22 companies with 26 mines produced fire clay (3 companies with 4 mines produced both). Nine companies with 20 mines accounted for 57% of the State's common clay and shale and 39% of the fire clay. Among the leading producers were Filtrol Corp., Belden Brick Co., Southwestern Portland Cement Co., Marquette Cement Manufacturing Co. (acquired during the year by Gulf+Western Industries, Inc.), Medusa Corp., Zoar Mining Co., and Swank Refractories Co.

Gem Stones.—Gem and mineral specimen collectors searched for flint, Ohio's official gem stone, in the vicinity of Flint Ridge in southeastern Licking County and the adjacent area of Muskingum County. Various other mineral specimens were also collected, including calcite, celestite, and quartz.

Graphite (Synthetic).—The Ohio Carbon Co. produced graphite shapes from petroleum coke and from pitch coke at its Cleveland plant. Output and value increased over that of 1975.

Gypsum.—Crude gypsum production from Ohio's two gypsum mines in Ottawa County near Sandusky Bay decreased 21% and was 40% below the 1972 record high. The Celotex Corp. mined gypsum at an open pit, and United States Gypsum Co. operated an underground mine, which was shut down early in November. Mining equipment was removed from the underground mine and it was permitted to flood with water which seeped in from adjacent rock strata.

Gypsum was calcined by The Celotex Corp. and United States Gypsum Co. at plants in Ottawa County, and by National Gypsum Co. at a plant in Lorain County. Output of calcined gypsum was 396,000 tons, 17% more than that of 1975.

Lime.—Ohio ranks first in lime production and consumption, accounting for 19% of the Nation's output and 14% of the Nation's consumption in 1976. Sixteen companies produced lime at 17 plants in 10 counties. Leading counties were Sandusky,

Lake, Lorain, Erie, and Seneca. Other lime-producing counties were Ashtabula, Cuyahoga, Hancock, Ottawa, and Wyandot. Leading producers were Martin Marietta Corp., Diamond Shamrock Corp., United States Steel Corp., Republic Steel Corp., and Huron Lime Co. Ohio's lime production in 1976 increased 9% to 3,788,000 tons, and the total value of production increased 20% to \$114,299,000. The lime was used in steel-making furnaces, refractory dolomite, alkalies, glass, and other uses. Lime consumption in Ohio in 1976 was 2,814,000

tons compared with 2,762,000 tons in the previous year.

In June, Diamond Shamrock Corp. announced phaseout and shutdown of its Painesville (Lake County) chemical works, including the lime plant, by yearend. The lime was used in a process to produce synthetic soda ash. The firm cited rising energy costs for the energy-intensive synthetic soda ash process, pollution control problems, and increasing competition from natural soda ash as reasons for the shutdown.

Table 8.—Ohio: Lime sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Steel, BOF -----	1,719	43,870	1,892	55,520
Refractory dolomite -----	468	15,120	581	20,887
Glass -----	251	6,400	189	5,715
Steel, electric -----	91	2,316	90	2,728
Finishing lime -----	76	2,279	79	2,617
Sewage treatment -----	27	691	36	1,087
Mason's lime -----	39	1,182	34	1,139
Agriculture -----	11	418	12	510
Other uses ¹ -----	800	22,860	876	24,095
Total ² -----	3,482	95,186	3,788	114,299

¹ Includes alkalies, magnesite, calcium carbide, open-hearth steel furnaces, water purification, other chemical uses, sugar refining, fertilizer, soil stabilization, other metallurgy, and rubber.

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

Perlite (Expanded).—Crude perlite shipped to Ohio from mines in the Western States was expanded by United States Gypsum at its gypsum plant in Ottawa County, National Gypsum Co. at its gypsum plant in Lorain County, The Celotex Corp. at Lockland in Hamilton County, and Cleveland Gypsum Co. at Cleveland in Cuyahoga County. The quantity of expanded perlite sold or used totaled 11,703 tons, 2% below that of the previous year. Total value decreased 4% to \$952,000. Average value per ton decreased compared with that of 1975. The principal uses for perlite in Ohio were for plaster aggregate, various formed products, insulation, and miscellaneous industrial uses.

Quartz Crystal (Cultured).—Ohio is the world's leading producer of cultured quartz crystal. Three companies, all in northeast Ohio, produced cultured quartz for telecommunications equipment, televisions, and time pieces. Sawyer Research Products, Inc.,

a subsidiary of Brush Wellman Inc., is the world's largest producer with a plant at Eastlake in Lake County. Bliley Electric Co. produced cultured quartz crystal at Cortland in Trumbull County, and Crystal Systems Inc. at Chardon in Geauga County. Output increased 16% in quantity and 17% in value over that of the previous year. In January, Sawyer Research Products announced a \$2.5 million expansion of its quartz-growing facilities at Eastlake. A second expansion, at a cost of \$2 million, was announced in June. Expansion construction was completed in early 1977.

Salt.—Ohio continued to rank fourth nationally in salt production after Louisiana, Texas, and New York. Salt sold or used totaled 5,052,000 tons, less than 1% below the quantity sold or used in 1975. However, the value of Ohio's salt output in 1976 increased 21% to \$66,332,000. Much of the increase in total value resulted from increased prices for evaporated salt. The aver-

age value of salt increased \$2.38 per ton to \$13.13 compared with \$10.75 per ton in 1975. Four firms with six operations located in four counties sold or used salt in the forms of rock, brine, and evaporated brine. Rock salt was recovered from underground mines in Cuyahoga and Lake Counties. Brine was pumped from wells in Lake, Summit, and Wayne Counties. Evaporated salt was produced from brine by both the open-pan and vacuum processes in Summit and Wayne Counties. Ohio's salt output was used mainly for control of ice on highways, various chemical applications, and human and animal consumption. Apparent consumption of salt (excluding brine) in Ohio in 1976 totaled 2,055,000 tons of which 1,687,000 tons was rock salt and 368,000 tons was evaporated salt. Due primarily to the severe winter in Ohio, rock salt consumption in 1976 was 34% greater than that of 1975.

Sand and Gravel.—Ohio's 295 sand and gravel producers mined 38,876,000 tons of construction and industrial sand and gravel valued at \$76,730,000, an increase of 5% in quantity and 12% in value over 1975 levels.

Among the States, Ohio ranked fifth in the output of sand and gravel, accounting for 4.4% of total U.S. production.

Construction sand and gravel accounted for 97% of the total Ohio output and 93% of the total value. Of the 37,790,000 tons of construction sand and gravel produced, 19,164,000 tons was sand with an average value of \$1.63 per ton, and 18,625,000 tons was gravel with an average value of \$2.14 per ton. The principal uses for sand and gravel were concrete aggregate (37%), asphaltic concrete and other bituminous mixtures (3%), fill (12%), roadbase and coverings (10%), concrete products (8%), and other uses (3%).

Industrial sand and gravel accounted for 3% of the total output and 7% of the total value. Of the 1,086,000 tons of industrial sand and gravel produced, 940,000 tons was sand valued at \$5.22 per ton, and 146,000 tons was gravel valued at \$4.40. The principal uses for industrial sand and gravel were for molding sand, foundry sand, glass manufacture, and various other metallurgical and industrial uses.

Table 9.—Ohio: Construction sand and gravel sold or used by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	13,826	26,358	14,089	28,429
Concrete products (cement blocks, bricks, pipes, etc.)	2,568	4,790	2,850	5,842
Asphaltic concrete aggregates and other bituminous mixtures	11,461	21,257	11,494	22,857
Roadbase and coverings	3,541	5,811	3,613	6,491
Fill	4,348	5,214	4,570	6,188
Other uses	672	1,065	1,172	1,876
Total ¹	36,417	64,493	37,790	71,176

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

The average unit value of Ohio's sand and gravel, construction and industrial combined, increased 13 cents from \$1.84 per ton in 1975 to \$1.97 per ton in 1976.

Sand and gravel was produced in 63 counties at 332 mines. Output exceeded 1 million tons in each of 11 counties. Hamilton County was the leading producer with 3.7 million tons, followed by Butler with almost 3 million tons, Portage with 2.8 million tons, and Franklin with 2.7 million

tons. Only five mines produced 700,000 tons or more each. Seven mines produced between 400,000 and 700,000 tons each; 49, between 200,000 and 400,000 tons each; 70, between 100,000 and 200,000 tons each; and the remaining mines less than 1,000 tons each. The largest producers were American Aggregates Corp., which operated 13 sand and gravel mines; Ohio Gravel Div., Dravo Corp., with 6 mines; and American Materials Corp. with 3 mines.

Table 10.—Ohio: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Ashland	4	216	382	4	158	286
Ashtabula	9	109	195	6	117	174
Athens	4	190	440	4	145	375
Auglaize	4	381	664	4	427	819
Brown	2	W	W	1	19	53
Butler	12	2,639	4,102	12	2,957	5,037
Champaign	4	244	421	4	235	428
Clark	9	953	1,844	8	985	1,727
Clermont	1	96	214	1	96	214
Clinton	1	13	23	1	13	23
Columbiana	2	12	19	4	139	392
Coshocton	6	437	749	6	385	647
Cosworth	1	23	56	—	—	—
Crawhoga	2	W	W	—	—	—
Darke	4	461	901	4	375	816
Defiance	2	W	W	1	2	2
Erie	6	129	424	6	86	322
Frankfield	3	310	627	2	W	W
Franklin	10	2,686	4,900	10	2,681	5,281
Gallia	3	103	214	2	W	W
Geauga	4	653	1,670	6	1,089	3,786
Greene	10	733	1,261	10	801	1,360
Hamilton	16	4,162	6,765	16	3,743	6,783
Henry	1	66	153	1	81	194
Highland	1	22	17	1	23	65
Jackson	1	13	68	1	19	77
Knox	5	409	776	5	671	1,315
Lawrence	1	W	304	2	W	W
Licking	3	577	913	7	532	937
Logan	4	194	314	4	211	344
Lorain	4	476	1,043	3	376	895
Lucas	3	509	726	3	475	790
Madison	3	178	279	3	119	173
Mahoning	1	29	62	1	29	62
Marion	4	230	411	5	308	529
Medina	6	442	801	8	923	1,676
Meigs	4	1,458	3,236	4	1,728	3,734
Miami	7	743	1,414	9	744	1,433
Montgomery	11	1,989	3,450	12	1,919	3,543
Morrow	1	81	140	1	98	164
Pickaway	3	392	575	3	375	634
Pike	3	354	644	4	297	582
Portage	27	3,234	6,598	25	2,802	6,491
Richland	5	523	947	6	594	1,131
Ross	9	1,142	2,729	8	777	1,983
Scioto	4	165	320	4	257	522
Shelby	5	237	376	6	409	537
Stark	12	1,653	3,676	13	1,643	3,708
Summit	16	1,277	2,531	19	1,402	2,710
Tuscarawas	10	1,340	2,455	11	1,351	2,473
Warren	9	1,343	2,417	10	1,704	3,181
Washington	5	266	493	6	454	875
Wayne	4	521	973	4	514	969
Williams	5	306	559	5	365	658
Wyandot	4	234	371	4	205	335
Other counties ¹	22	2,131	3,418	22	2,903	5,483
Total ²	327	37,195	68,552	332	38,876	76,780

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

¹ Includes Belmont (1976), Carroll, Hocking, Holmes, Huron, Lake, Morgan, Muskingum, Preble, and Trumbull Counties.

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

About 89% of Ohio's sand and gravel output was transported to consumers by truck, 6% by water, and 1% by rail. The remainder, 4%, was transported by other means or used at the minesites.

Ohio Gravel Division of Dravo Corp. began selling sites in an industrial park and recreation area in what was a former sand and gravel mine at Newton in Hamilton County. Completion of the first 40-acre

phase of the reclamation development project is expected by 1985.

In June, the Ohio Department of Natural Resources announced the first legal action under the Ohio Strip Mine Law which requires reclamation of surface-mining areas where minerals other than coal are extracted. The action was taken against a sand and gravel mine in Fairfield County for operating without a license.

Slag (Iron Blast-Furnace).—Output of iron blast-furnace slag totaled 5,792,000 tons valued at \$16,526,000, according to the National Slag Association. The quantity produced was 8% more and the value 24% more than that of 1975. The average unit value increased 36 cents from \$2.49 per ton in 1975 to \$2.85 per ton in 1976.

Screened air-cooled iron blast-furnace slag comprised 87% of the total tonnage and 85% of the total value. The remaining output was unscreened air-cooled slag, granulated slag, and expanded slag. Most of the air-cooled slag was used as an aggregate in highway construction and repair, or as a raw material in the manufacture of mineral wool.

Stone.—Output of all types of stone totaled 42.7 million tons with a value of \$106,996,000. Compared with the previous

year, the quantity produced declined 8%, and the value of production declined 1.5%. Stone output in 1976 was as follows: Crushed and broken limestone and dolomite, 41,229,000 tons with a value of \$95,063,000 (96.6% of the total tonnage and 88.8% of total value); crushed and broken sandstone and quartzite, 1,384,000 tons with a value of \$8,995,000 (3.2% of total tonnage and 8.4% of total value); and dimension limestone and sandstone, 87,286 tons with a value of \$2,936,000 (0.2% of total tonnage and 2.7% of total value).

Compared with that of 1975, output of crushed and broken limestone in 1976 decreased 8.3% in quantity and 3.4% in value; crushed and broken sandstone and quartzite increased 8.4% in quantity and 25% in value; and dimension limestone and sandstone increased 1.3% in quantity and decreased 3.1% in value.

The average value of all crushed and broken stone increased 16 cents per ton to \$2.44, that of limestone and dolomite increased 12 cents to \$2.31 per ton, and that of sandstone and quartzite increased 87 cents to \$6.50. The average value of dimension limestone and sandstone decreased \$1.53 to \$33.64 per ton.

Table 11.—Ohio: Crushed and broken limestone and dolomite sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate	2,583	5,741	2,712	5,957
Concrete aggregate	5,455	11,536	5,908	12,851
Dense-graded roadbase stone	4,748	9,871	4,217	9,456
Macadam aggregate	5,933	11,611	5,085	11,169
Surface treatment aggregate	2,092	4,689	2,082	4,749
Other construction aggregate and roadstone	5,251	11,051	4,070	8,858
Agricultural purposes ¹	2,556	6,501	2,250	6,543
Cement manufacture	4,107	9,799	3,414	8,334
Dead-burned dolomite	795	1,412	1,087	2,005
Filter stone	39	77	W	119
Glass manufacture	459	2,860	447	3,032
Lime manufacture	2,791	4,702	3,186	5,699
Manufactured fine aggregate (stone sand)	363	864	400	893
Flux stone	4,022	8,365	3,567	7,968
Railroad ballast	1,453	2,736	961	1,841
Riprap and jetty stone	903	2,223	1,039	2,547
Other uses ²	1,390	4,820	803	3,041
Total ³	44,940	98,358	41,229	95,063

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

¹ Data include agricultural limestone, other soil conditioners, and poultry grit and mineral food.

² Includes terrazzo and exposed aggregate, disinfectant, refractory stone, chemical stone, mine dusting, whitening, asphalt filler, other fillers, and uses not specified.

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

Table 12.—Ohio: Crushed and broken limestone and dolomite sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1975		1976	
	Quantity	Value	Quantity	Value
Allen	967	2,056	848	1,898
Belmont	140	433	116	387
Brown	57	104	51	114
Clinton	W	W	440	960
Delaware	1,350	2,635	840	1,744
Erie	W	W	2,840	5,484
Greene	1,540	2,887	W	W
Hancock	497	971	408	873
Harrison	230	455	W	W
Highland	521	1,227	W	W
Lawrence	15	63	W	W
Logan	354	676	290	595
Lucas	1,779	3,989	2,048	4,823
Mahoning	2,907	6,717	2,385	6,201
Marion	823	1,708	633	1,415
Miami	W	W	937	3,275
Morgan	63	163	W	13
Muskingum	1,715	5,552	1,738	5,863
Noble	W	W	201	432
Ottawa	4,002	9,391	3,185	7,023
Preble	W	W	5	14
Putnam	223	509	199	474
Sandusky	5,646	12,026	5,961	13,654
Shelby	232	358	133	W
Van Wert	719	1,222	W	W
Washington	24	79	26	103
Wood	1,198	2,698	1,160	2,708
Wyandot	3,077	6,654	2,379	5,773
Undistributed ¹	16,839	35,789	14,304	31,730
Total ²	44,940	98,358	41,229	95,063

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

¹ Includes Adams, Athens, Auglaize, Carroll, Clark, Clermont, Crawford, Fayette, Franklin, Galia (1975), Guernsey, Hardin, Holmes, Jackson, Lorain (1976), Madison, Mercer, Monroe, Montgomery, Paulding, Perry, Pickaway, Pike, Ross, Seneca, Stark, Summit, Tuscarawas, Union, Warren, and Wayne Counties.

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

Stone was produced by 115 companies at 169 quarries in 65 counties. Eleven quarries had an output exceeding 900,000 tons each; 13, between 500,000 and 900,000 tons each; 71, between 100,000 and 500,000 tons each; and 74, less than 100,000 tons each, of which 46 produced less than 25,000 tons each. Six counties had an output exceeding 2 million tons each. Sandusky County, with an output of 5,961,000 tons of crushed and broken stone was the leading producer, followed by Ottawa County with 3.2 million tons, Erie with 2.8 million tons, Mahoning and Wyandot with 2.4 million tons each, and Lucas with 2.0 million tons. National Lime & Stone Co. and France Stone Co. were the largest producers of crushed stone, all of which was limestone.

About 69% of Ohio's stone production was transported by truck; 15%, by railroad; 4%, by water; and 12%, by other means. Erie County ranked first among all coun-

ties in truck haulage with 2.5 million tons of stone transported by this method, followed by Lucas County with 2.0 million tons, and Sandusky County with 1.8 million tons. In the 18 counties where railroad haulage was employed, Sandusky County ranked first with 1.9 million tons, followed by Wyandot County with 1.4 million tons and Mahoning County with 0.7 million tons. Waterway transportation of stone originated on the Ohio River in Adams County and on Lake Erie in Ottawa and Sandusky Counties. Ottawa County led in waterway stone shipments with 1.7 million tons.

The principal uses for crushed and broken limestone and dolomite in 1976 were roadbase and paving materials (44%), concrete aggregate (14%), flux stone (9%), cement manufacture and manufacturing lime (8% each), agricultural uses (5%), riprap and jettystone applications and for the manufacture of dead-burned dolomite

(about 3% each), and railroad ballast, glass manufacture, and various other miscellaneous chemical and industrial uses (about 5%).

Crushed and broken sandstone and quartzite were used principally in glass manufacture, refractory applications, flux stone, aggregate, and various miscellaneous uses.

Dimension sandstone was sold principally as sawed stone, rough blocks, and rubble. Dimension limestone was used for rubble.

At the end of January, PPG Industries, Inc., shut down its Barberton mine, the deepest limestone quarry in the world. The one-half-mile-deep underground operation, located at Norton in Summit County, had been in production since the early 1940's. Stone from the mine was used as raw material to manufacture soda ash and cement, both of which are no longer produced by the firm at this plant facility. Only 16 miners were employed when the mine was closed, compared with 150 miners during peak years of production. Later in the year, the Federal Energy Research and Development Administration considered leasing the mine for research in storage of radioactive wastes but subsequently abandoned the idea as being too costly.

Ohio limestone producers joined those in several other Midwestern States to contest a decision by Conrail to use traprock in place of limestone for ballast in rail line rehabilitation. The traprock is produced in eastern Pennsylvania and shipped to rail line rehabilitation projects in market areas formerly served by midwestern limestone producers. The limestone producers organized a committee to take action on the matter and an engineering consultant was hired to develop data on the use of limestone as railroad ballast.

Sulfur.—Sulfur was recovered from crude petroleum by Standard Oil Co. of Ohio at its Lima refinery in Allen County, Gulf Oil Co. at its Toledo refinery in Lucas County, and Ashland Oil Inc. at its Canton refinery in Stark County. Sales increased 13% in volume and 12% in value.

Vermiculite (Exfoliated).—The Cleveland Gypsum Co., a division of Cleveland Builders Supply Co., processed crude vermiculite mined out-of-State and shipped to its Cleveland plant. Production and sales decreased, but value of sales increased slightly over that of 1975. The exfoliated

vermiculite was used primarily for soil conditioning and insulation.

METALS

Aluminum.—Ormet Corp., jointly owned by Consolidated Aluminum Corp. and Revere Copper & Brass, Inc., produced primary aluminum at the Hannibal reduction plant by reducing alumina obtained by barge from a company-owned plant at Burnside, La. Production of primary aluminum increased in quantity and value. During 1976, the plant began to recover from the recession which forced the layoff of nearly one-half of the 2,200 employees and caused the shutdown of 3 of the plant's 6 potlines in the first part of 1975. By the middle of 1977, many of the employees had been rehired and the three potlines had been placed back into service.

Beryllium.—The Cleveland-based beryllium producer, Brush Wellman, Inc., announced plans to discontinue processing of beryllium ore at its Elmore plant in Ottawa County. Beryl ore-processing will be discontinued during 1977, and the company's plant near Delta, Utah, will become the only operating beryllium ore extraction facility in the United States. The Elmore plant will continue to produce beryllium metal, alloys, oxide, and other compounds from beryllium hydroxide received from the Delta plant, as well as shapes from beryllium metal and alloys, and ceramics for electrical use from beryllium oxide.

Ferroalloys.—Ohio continued as the leading producer of ferroalloys, accounting for about one-third of the national total. Shipments increased 10% to 656,758 tons compared with 598,570 tons in 1975. However, output was considerably below quantities produced in 1974 and 1973. Value of shipments in 1976 totaled \$366,886,000. Six companies produced ferroalloys at eight plants in Ashtabula, Guernsey, Jefferson, Monroe, Muskingum, and Washington Counties. The ferroalloys produced were mainly alloys of iron, chromium, manganese, silicon, and vanadium.

At midyear, Satralloy, Inc., activated a 10-megavolt-ampere furnace to produce high-carbon ferrochromium at its Steubenville plant. Foote Mineral Co. reported record high furnace efficiency in the production of vanadium ferroalloys at its Cambridge plant. Operations at Ohio Ferro-Alloys

Corp.'s Philo plant were hampered for more than 5 months in 1976 because of the loss of a 65,000 kilovolt-ampere transformer. The company was forced to operate an older, less efficient furnace to offset loss of production from larger furnaces affected by the transformer breakdown.

Iron Oxide Pigments.—Two firms manufactured synthetic iron oxide pigments. Ottawa Chemical Div., Ferro Corp., produced synthetic red iron oxide pigment at its plant in Lucas County, and Hilton Davis Chemicals Div., Sterling Drug Inc., produced synthetic yellow iron oxide pigment in Hamilton County.

Iron and Steel.—Ohio's production of pig iron was 15,762,000 tons, an increase of 1,642,000 tons or 12%. Pig iron shipments totaled 15,666,000 tons valued at \$2,856,009,000, compared with the previous year's shipments of 13,959,000 tons valued at \$2,529,634,000. The average value of pig iron increased about \$1.00 per ton from \$181.22 per ton in 1975 to \$182.31 per ton in 1976. Pig iron was made in blast furnaces, 24 of which were in operation at the beginning of the year, 28 (maximum for the year) were in operation from April to July, and 21 were in operation at yearend. Ohio has a total of 39 blast furnaces.

Steel production in Ohio reported by the American Iron and Steel Institute was 22,419,000 tons, an increase of 2,799,000 tons or 14%. Ohio ranked second in steel production after Pennsylvania.

The principal pig iron and steel producers in Ohio are Armco Steel Co. in Butler County; Jones & Laughlin Steel Corp. in Cuyahoga County; Republic Steel Corp. with major facilities in Cuyahoga, Mahoning, Trumbull, and Stark Counties; United States Steel Corp. in Cuyahoga, Lorain, Mahoning, and Trumbull Counties; and Youngstown Sheet & Tube Co. in Mahoning County. All of these firms produced pig iron in blast furnaces and steel in basic oxygen furnace (BOF) shops, except Youngstown Sheet & Tube Co. and United States Steel at their Mahoning County operations, where open-hearth furnaces were used to produce steel. Steel was also produced from scrap in electric furnaces.

Republic Steel Corp. completed installation of a \$20 million baghouse at its Canton plant to collect dust and particulate matter from a new stainless steel refining vessel and three 100-ton electric arc melting fur-

naces. Work was completed on the first phase of construction of a suppressed combustion pollution control system for the BOF's at the Cleveland plant. The system, believed to be the first of its type ever installed on an existing steel-working complex, replaces a bank of electrostatic precipitators which will be used to control other emissions in steelmaking at the plant. The new system became fully operational during 1977.

An example of advancing BOF technology was reported by Jones & Laughlin Steel Corp. at its Cleveland plant. In 1972, a single BOF produced about 500 heats of steel before it had to be shut down and relined with new refractories. During 1976, the BOF's averaged 999 heats between relining operations, and officials at the plant believe this may be increased to 1,500 heats by 1980. The increased performance of the BOF's was attributed to the use of new and better refractories, water-cooled cones for the BOF topsides, improved oxygen lance design, and better maintenance and furnace operation.

Titanium.—New Jersey Zinc Co. and Glidden-Durkee Div. of SCM Corp. produced titanium dioxide pigment at plants in Ashtabula. Both companies were considering expansion of the chloride process plants. Titanium dioxide pigment is used in paints, paper coatings, plastics, and in a wide variety of miscellaneous applications.

The RMI Co. produced titanium sponge metal by sodium reduction of titanium tetrachloride at its Ashtabula plant. RMI was the only domestic producer to sell titanium sponge on the open market. The company also shipped titanium sponge to its Niles plant for melting and processing.

Primary titanium metal shipped from Henderson, Nev., was rolled and fabricated at Toronto in Jefferson County by Titanium Metals Corp. of America. The company was reportedly installing its sixth titanium tubing production line and accelerating production on the other five lines to keep up with demand.

Zinc.—ASARCO Incorporated produced zinc oxide directly from zinc concentrates at its Columbus plant in Franklin County. Output was significantly higher in 1976 than in 1975. The principal uses for the zinc oxide were in the manufacture of rubber, paint, ceramics, and various chemical applications.

Zirconium.—Foote Mineral Co. processed zircon at its Cambridge plant in Guernsey County to produce zirconium alloys. Harshaw Chemical Co., Inc., recovered zirconia at its plant in Elyria, Lorain County, for use as ceramic-base colors. Ohio Ferro-Alloys Corp. produced zirconium and silicon alloys at Brilliant in Jefferson County. Zirconium Corp. of America produced zirconia and zirconia ceramics and refractories at its Solon plant in Cuyahoga County. NL Industries, Inc. (formerly

Charles Taylor Sons Co.) produced zircon refractories in Cincinnati, Hamilton County. Continental Mineral Processing Corp. milled zircon at Sharonville in Hamilton County for use by iron and steel foundries and the ceramic industry. Sherwood Refractories Co. at Cleveland in Cuyahoga County produced zircon cores and molds for investment casting of high-temperature alloys. Lincoln Electric Co., Inc., also at Cleveland, produced zircon-based welding rod coatings.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Columbia Cement Corp. ^{1 2}	Box 1531 Zanesville, Ohio 43701	Plant -----	Muskingum.
General Portland Cement Co. ^{1 2}	709 Clay St. Fort Wayne, Ind. 46802	----do -----	Paulding.
Marquette Cement Manufacturing Co. ^{1 2}	20 North Wacker Dr. Chicago, Ill. 60606	----do -----	Lawrence.
Medusa Corp. ^{1 2 3}	Box 5668 Cleveland, Ohio 44101	----do -----	Lucas.
Southwestern Portland Cement Co. ^{1 2}	Box 191 Fairborn, Ohio 45324	----do -----	Greene.
Clays:			
Belden Brick Co -----	Box 910 Canton, Ohio 44701	Pits -----	Tuscarawas.
Swank Refractories Co ---	101 Swank Court Johnstown, Pa. 15209	----do -----	Columbiana and Jefferson.
Zoar Mining Co -----	Box 550 Zoar, Ohio 44697	----do -----	Tuscarawas.
Coal:			
Central Ohio Coal Co ----	Box 18, Bowling Green Station New York, N.Y. 10004	Strip mines ----	Morgan and Muskingum.
Consolidation Coal Co ----	Cadiz, Ohio 43907 -----	Strip, auger, underground mines.	Belmont, Harrison, Jefferson.
Hardy Coal Co -----	Route 2, Box 163 Sugarcreek, Ohio 44681	Strip mines ----	Coshocton, Holmes, Tuscarawas.
North American Coal Corp.	12800 Shaker Blvd. Cleveland, Ohio 44120	Underground mines	Belmont and Jefferson.
Peabody Coal Co -----	301 North Memorial Dr. St. Louis, Mo. 63102	Strip and under- ground mines, plant.	Coshocton and Perry.
R&F Coal Co -----	Box 218 Cadiz, Ohio 43907	----do -----	Belmont, Guernsey, Harrison, Jefferson.
Ferroalloys:			
Foote Mineral Co -----	Route 100 Exton, Pa. 19341	Plants -----	Guernsey and Jefferson.
Interlake, Inc -----	18-5th St. & Ferry Ave. Chicago, Ill. 60604	----do -----	Washington.
Ohio Ferro-Alloys Corp ---	339 30th NW. Canton, Ohio 44709	----do -----	Jefferson, Monroe, Muskingum.
Union Carbide Corp. ⁴ ----	Box 176 Marietta, Ohio 45750	----do -----	Ashtabula and Washington.
Graphite, synthetic: Ohio Carbon Co.	12508 Berea Rd. Cleveland, Ohio 44111	----do -----	Cuyahoga.
Gypsum:			
The Celotex Corp. ⁵ -----	1500 North Dale Mabry Tampa, Fla. 33607	Pit, plant -----	Ottawa.
National Gypsum Co. ^{1 4 5} -	325 Delaware Ave. Buffalo, N.Y. 14202	Plant -----	Lorain.
United States Gypsum Co. ^{1 3 4 5}	101 South Wacker Dr. Chicago, Ill. 60606	Underground mine, plant.	Ottawa.

See footnotes at end of table.

Table 13.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Lime:			
Basic, Inc. ¹ -----	845 Hanna Bldg. Cleveland, Ohio 44115	Plant -----	Seneca.
Huron Lime Co -----	Box 428 Huron, Ohio 44839	---do -----	Erie.
Martin Marietta Corp. ¹ --	Executive Plaza II Hunt Valley, Md. 21030	---do -----	Sandusky.
Republic Steel Corp -----	Box 6778 Cleveland, Ohio 44101	---do -----	Lake.
Woodville Lime & Chemical Co. ¹ -----	Box 218 Woodville, Ohio 43469	---do -----	Sandusky.
Peat:			
Reynolds Farms, Inc -----	Route 1 Shelby, Ohio 44875	Bog -----	Richland.
Perlite, expanded:			
Cleveland Gypsum Co., a division of Cleveland Builders and Supply Co. ⁶	2100 West 3d St. Cleveland, Ohio 44113	Plant -----	Cuyahoga.
Petroleum refineries:			
Ashland Oil and Refining Co. -----	1409 Winchester Ave. Ashland, Ky. 41101	Plants -----	Hancock and Stark.
Chevron Asphalt Co -----	223 Bush St. San Francisco, Calif. 94104	Plant -----	Hamilton.
Gulf Oil Corp -----	Box 1166 Pittsburgh, Pa. 15230	Plants -----	Hamilton and Lucas.
Standard Oil Co. of Ohio --	Midland Bldg. Cleveland, Ohio 44115	---do -----	Allen and Lucas.
Sun Oil Co -----	1608 Walnut St. Philadelphia, Pa. 19103	Plant -----	Lucas.
Salt:			
Diamond Shamrock Corp. ⁴	300 Union Commerce Bldg. Cleveland, Ohio 44115	Well -----	Lake.
International Salt Co ----	Clarks Summit, Pa. 18411	Underground mines	Cuyahoga.
Morton-Norwich Products, Inc. -----	110 North Wacker Dr. Chicago, Ill. 60606	---do -----	Lake and Wayne.
Sand and gravel:			
American Aggregates Corp. ¹ -----	Garst Ave. at Ave. B Greenville, Ohio 45331	Pits -----	Various.
American Materials Corp --	Box 160 Greenville, Ohio 45331	---do -----	Butler.
Dravo Corp -----	5253 Wooster Rd. Cincinnati, Ohio 45226	---do -----	Butler, Hamilton, Warren.
Tri-State Materials Corp --	Box 1169 Parkersburg, W. Va. 26101	Pit -----	Meigs.
Twin Lakes Sand Co -----	2307 State Route 303 Streetsboro, Ohio 44240	Pits -----	Portage.
Stone:			
Carbon Limestone Co ----	Lowellville, Ohio 44436 --	Quarries -----	Mahoning.
Davon, Inc -----	2152 Tremont Ctr. Columbus, Ohio 43221	---do -----	Adams and Highland.
France Stone Co -----	1800 Toledo Trust Bldg. Toledo, Ohio 43604	---do -----	Lucas, Sandusky, Seneca.
Maumee Stone Co -----	Box 369 Maumee, Ohio 43537	---do -----	Lucas, Ottawa, Paulding, Wood.
National Lime & Stone Co. ⁴ -----	First National Bank Bldg. Findlay, Ohio 45840	---do -----	Various.
Sandusky Crushed Stone Co. ⁴ -----	Box 527 Sandusky, Ohio 44870	Quarry -----	Erie.
Standard Slag Co -----	1200 Stambaugh Bldg. Youngstown, Ohio 44501	Quarries -----	Ottawa.

¹ Also stone.² Also clays.³ Also sand and gravel.⁴ Also lime.⁵ Also expanded perlite.⁶ Also exfoliated vermiculite.

The Mineral Industry of Oklahoma

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey under a cooperative agreement for collecting information on all minerals except fuels.

By R. H. Arndt,¹ K. S. Johnson,² and J. F. Roberts²

The value of raw mineral production in Oklahoma leaped forward with renewed vigor in 1976 to a total of \$2.8 billion, 23% above that of 1975. The value of energy materials, including crude petroleum, natural gas, natural gas liquids, helium, and coal, increased 23.5% compared with that of the previous year and accounted for 95.8% of the total value of minerals produced. The total value of all other produced metal and nonmetal materials was 12% over that of 1975. Measured in 1967 constant dollars, the total mineral output had a value of \$1 billion for a gain

of 11.8% over that in 1975. Oklahoma ranked seventh among all States in value of raw mineral production. Those commodities that ranked significantly in relation to production in other States were natural gas (third), natural gas liquids (third), crude oil (fourth), and gypsum (fifth). Decreases in production, compared with 1975 levels, were experienced by crude oil and stone. No copper or silver was pro-

¹ State Liaison Officer, Bureau of Mines, Oklahoma City, Okla.

² Geologist, Oklahoma Geological Survey, Norman, Okla.

Table 1.—Mineral production in Oklahoma¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	995	\$1,701	1,155	\$1,678
Coal (bituminous) ----- do	2,872	47,946	3,635	58,102
Gypsum ----- do	1,028	4,835	1,120	5,822
Helium:				
High purity ----- million cubic feet	224	7,411	243	7,686
Crude ----- do	148	1,776	181	2,172
Natural gas ----- do	1,605,410	513,731	1,726,518	866,710
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels	10,835	63,383	10,894	74,416
LP gases ----- do	29,640	140,197	31,620	179,602
Petroleum (crude) ----- do	163,123	1,389,164	161,426	1,484,297
Pumice ----- thousand short tons	1	W	1	W
Sand and gravel ----- do	9,591	16,749	10,037	19,050
Stone ----- do	20,111	36,840	19,635	37,339
Value of items that cannot be disclosed:				
Cement, copper (1975), feldspar (1976), lead (1976), lime, pumice, salt, silver (1975), tripoli, zinc (1976), and values indicated by symbol W -----	XX	43,362	XX	53,100
Total -----	XX	2,267,095	XX	2,789,974
Total 1967 constant dollars -----	XX	897,089	XX	1,002,996

² Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

Table 2.—Value of mineral production in Oklahoma, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adair -----	\$31	\$31	Sand and gravel.
Alfalfa -----	21,548	31,231	Petroleum, natural gas, natural gas liquids, sand and gravel.
Atoka -----	W	W	Stone, petroleum, sand and gravel.
Beaver -----	83,904	88,705	Petroleum, natural gas, natural gas liquids, sand and gravel, pumice.
Beckham -----	8,471	11,049	Natural gas, natural gas liquids, petroleum.
Blaine -----	47,103	83,078	Natural gas, petroleum, natural gas liquids, gypsum, sand and gravel.
Bryan -----	4,117	4,778	Natural gas, petroleum, stone, sand and gravel.
Caddo -----	49,268	120,384	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel, stone.
Canadian -----	46,011	90,610	Natural gas, petroleum, natural gas liquids, sand and gravel, clays, gypsum.
Carter -----	197,812	200,981	Petroleum, natural gas, natural gas liquids, sand and gravel.
Cherokee -----	W	W	Stone.
Choctaw -----	W	W	Stone, sand and gravel.
Cimarron -----	23,172	21,922	Helium, natural gas, petroleum, natural gas liquids.
Cleveland -----	18,312	18,220	Petroleum, natural gas, sand and gravel.
Coal -----	4,943	4,865	Petroleum, natural gas, stone.
Comanche -----	6,866	6,615	Stone, petroleum, natural gas, gypsum.
Cotton -----	6,737	6,693	Petroleum, sand and gravel, natural gas.
Craig -----	W	24,362	Coal, stone, petroleum, natural gas.
Creek -----	64,638	67,882	Petroleum, natural gas liquids, stone, natural gas, clays.
Custer -----	9,857	18,020	Natural gas, natural gas liquids, petroleum, sand and gravel, clays.
Delaware -----	W	W	Stone.
Dewey -----	57,429	92,102	Natural gas, petroleum, natural gas liquids.
Ellis -----	17,702	23,351	Natural gas, petroleum.
Garfield -----	57,370	76,560	Petroleum, natural gas, natural gas liquids, sand and gravel.
Garvin -----	104,745	107,873	Petroleum, natural gas liquids, natural gas, sand and gravel.
Grady -----	58,150	165,954	Natural gas, petroleum, natural gas liquids.
Grant -----	11,781	12,356	Petroleum, natural gas liquids, natural gas.
Greer -----	860	1,187	Natural gas, stone, petroleum, clays, sand and gravel.
Harmon -----	W	W	Salt.
Harper -----	40,354	44,013	Natural gas, natural gas liquids, petroleum, sand and gravel.
Haskell -----	W	W	Natural gas, coal.
Hughes -----	9,383	11,489	Petroleum, natural gas, sand and gravel.
Jackson -----	3,596	3,347	Petroleum, gypsum, sand and gravel.
Jefferson -----	5,602	5,063	Petroleum, natural gas.
Johnston -----	5,035	6,589	Sand and gravel, stone, petroleum.
Kay -----	34,269	37,534	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Kingfisher -----	116,095	133,779	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa -----	2,785	3,350	Stone, petroleum, natural gas.
Lattimer -----	W	16,211	Natural gas, sand and gravel, coal.
Le Flore -----	19,457	W	Coal, natural gas, clays, sand and gravel.
Lincoln -----	19,142	21,508	Petroleum, natural gas, natural gas liquids.
Logan -----	16,200	25,944	Petroleum, natural gas, natural gas liquids, sand and gravel.
Love -----	10,973	10,981	Petroleum, natural gas, natural gas liquids.
McClain -----	40,713	39,759	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain -----	W	W	Sand and gravel, stone.
McIntosh -----	W	W	Natural gas, stone.
Major -----	74,070	95,657	Natural gas, petroleum, natural gas liquids.
Marshall -----	3,865	9,973	Petroleum, natural gas liquids, natural gas.
Mayes -----	11,571	15,201	Cement, stone, clays, petroleum, sand and gravel.
Murray -----	12,821	13,160	Petroleum, stone, natural gas.
Muskogee -----	5,635	6,828	Petroleum, coal, sand and gravel, feldspar, natural gas, stone.
Noble -----	16,955	23,167	Petroleum, natural gas liquids, natural gas.
Nowata -----	5,337	6,103	Petroleum, coal, stone, natural gas.
Okfuskee -----	3,649	9,545	Petroleum, natural gas, natural gas liquids.
Oklahoma -----	47,856	57,481	Petroleum, natural gas liquids, natural gas, sand and gravel, clays.
Okmulgee -----	11,573	14,950	Petroleum, coal, natural gas, stone.
Osage -----	108,240	128,187	Petroleum, natural gas, stone.
Ottawa -----	1,291	1,098	Stone, tripoli, sand and gravel, zinc, lead.

See footnotes at end of table.

Table 2.—Value of mineral production in Oklahoma, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Pawnee -----	\$10,314	\$12,861	Petroleum, stone, natural gas, sand and gravel.
Payne -----	20,532	24,042	Petroleum, natural gas, sand and gravel.
Pittsburg -----	16,670	19,397	Natural gas, coal, stone, sand and gravel.
Pontotoc -----	62,786	72,154	Petroleum, cement, stone, sand and gravel, natural gas, clays, natural gas liquids.
Pottawatomie -----	22,333	23,333	Petroleum, natural gas, sand and gravel.
Pushmataha -----	W	1	Sand and gravel.
Roger Mills -----	8,369	16,917	Natural gas, petroleum.
Rogers -----	W	26,770	Cement, coal, petroleum, stone, clays, natural gas.
Seminole -----	51,889	54,902	Petroleum, natural gas liquids, stone, natural gas, sand and gravel, clays.
Sequoyah -----	4,572	5,628	Lime, natural gas, stone, sand and gravel.
Stephens -----	224,546	226,092	Petroleum, natural gas, natural gas liquids.
Texas -----	145,087	132,976	Natural gas, petroleum, natural gas liquids, sand and gravel.
Tillman -----	W	W	Petroleum, sand and gravel.
Tulsa -----	17,624	20,273	Petroleum, stone, sand and gravel, clays, natural gas.
Wagoner -----	853	2,054	Coal, petroleum, sand and gravel, natural gas.
Washington -----	7,699	W	Petroleum, stone, natural gas.
Washita -----	866	2,195	Natural gas, petroleum.
Woods -----	16,080	25,677	Natural gas, petroleum, sand and gravel, salt.
Woodward -----	26,361	42,343	Natural gas, natural gas liquids, petroleum sand and gravel.
Undistributed ² -----	93,075	52,632	
Total -----	^a 2,267,095	2,789,974	

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

¹ Petroleum is based on an average price per barrel for the State and natural gas is based on an average price per cubic foot for the State.

² Includes value of items 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 Oklahoma business activity

	1975	1976 ^b	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands...	1,155.0	1,159.0	+ 0.3
Unemployment ----- do-----	83.0	65.0	-21.7
Employment (nonagricultural):			
Mining ----- do-----	43.6	45.2	+ 3.7
Manufacturing ----- do-----	150.7	156.1	+ 3.6
Contract construction ----- do-----	45.9	44.6	- 2.8
Transportation and public utilities ----- do-----	56.5	57.2	+ 1.2
Wholesale and retail trade ----- do-----	208.5	222.2	+ 6.6
Finance, insurance, real estate ----- do-----	44.8	46.4	+ 3.6
Services ----- do-----	143.4	152.9	+ 6.6
Government ----- do-----	206.3	206.1	- .1
Total nonagricultural employment ----- do-----	899.7	930.7	+ 3.4
Personal income:			
Total ----- millions...	\$14,242	\$15,788	+ 10.9
Per capita ----- do-----	\$5,246	\$5,707	+ 8.8
Construction activity:			
Number of private and public residential units authorized...	10,208	15,805	+ 54.8
Value of nonresidential construction ----- millions...	\$167.3	\$282.1	+ 68.6
Value of State road contract awards ----- do-----	\$84.7	\$85.0	+ .4
Shipments of portland and masonry cement to and within the State ----- thousand short tons...	1,235	1,323	+ 7.1
Mineral production value:			
Total crude mineral value ----- millions...	\$2,267.1	\$2,790.0	+ 23.1
Value per capita, resident population ----- do-----	\$835	\$1,008	+ 20.7
Value per square mile ----- do-----	\$82,425	\$39,903	+ 23.1

^b Preliminary.

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

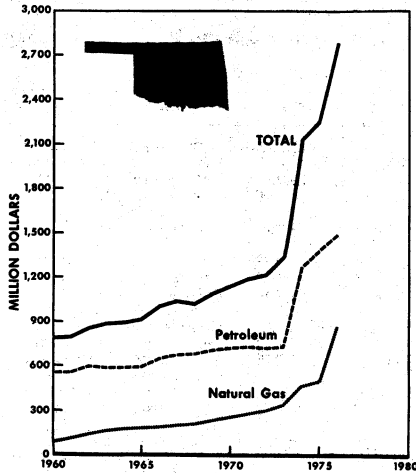


Figure 1.—Value of natural gas, petroleum, and total value of mineral production in Oklahoma.

duced after the State's only copper mine closed in 1975. Minor quantities of lead and zinc were recovered in renewed cleanup operations in the Miami-Picher area in Ottawa County. Output and value of all other minerals rose above that of 1975.

Legislation and Government Programs.—A bill to provide eminent domain for the construction and operation of coal slurry pipelines was reintroduced but was again defeated by the legislature. The "Orphan Lands" bill, which would have a fixed-figure tax of 25 cents per ton of coal produced in the State and provided that such revenue be used solely for the reclamation of abandoned strip-mined land, was vetoed by the Governor because the measure did not contain sufficient safeguards. In late December, the Governor announced that a similar act would be a major section of his program for the 1977 legislative session.

A special legislative committee established to investigate the Water Resources Board and a \$1.7 billion State water transfer plan the Board had supported recommended that planning for statewide water transfer be given to some other suitable planning agency selected by the legislature. The plan called for the transportation of water from eastern Oklahoma to the dry central and western parts of the State.

The State legislature authorized an investigation of the operations of public util-

ity companies and their subsidiaries be made by a special committee consisting of five members from each body of the legislature. This committee was to have subpoena powers.

A Department of Transportation was created under the Governor's plan for reorganization of the executive branch of the State government. The new agency incorporated the former State Highway Department and the planning resources of all other State agencies involved with various modes of transportation.

Under HB 1811, the State assumed authority over disposal of industrial waste through a newly created Industrial and Solid Waste Division in the Department of Health. The act authorized the Department of Health to issue permits for operation of industrial waste disposal facilities. Conditions under which permits may be issued were limited by passage of HB 1887, which prohibited establishment of hazardous waste disposal sites within the boundaries of or within 1 mile of the boundaries of any city or town, or within 1 mile of the public water supply of any city or town.

A bill was passed that would compel oil and gas firms to use only the gross production tax method to compute their tax liabilities. Previously, under certain circumstances, a firm had the right of choice between paying either a gross production

tax or an ad valorem tax on producing facilities.

The Oklahoma Corporation Commission (OCC) authorized expenditure of \$40,000 from the Conservation Fund to plug, re-plug, or repair any oil or gas wells as previously provided for by Oklahoma statutes.

A bill to terminate mineral interests that are dormant for 20 years and allow those mineral rights to escheat to the State was defeated by the legislature. The bill had considerable support from owners of rural surface land rights from which the subsurface mineral rights had been severed.

Activities of the Oklahoma Geological Survey centered on programs concerning energy, geologic mapping and minerals investigation, water supply and quality, environmental geology, and public service. Geologic mapping included field studies in Marshall and Washita Counties, preparation of several other county geologic maps, issuance of a "Map of Eastern Oklahoma Showing Active Coal Mines (Jan. 1, 1976)," by S. A. Friedman, and publication of Oklahoma Geological Survey Circular 76, "Shale and Carbonate-Rock Resources of Osage County, Oklahoma," by William H. Bellis and T. L. Rowland. Coalbeds of the Hartshorne formation in Haskell and Le Flore Counties were under study. Location, thickness, configuration, and chemistry of the coals were being ascertained with the aid of a grant from the Federal Bureau of Mines. In cooperation with the U.S. Geological Survey (USGS), the State agency continued an assessment of surface mining activities to locate each surface mine, the commodity mined, tonnage removed, and the amount of reclamation of the mined area for past, present, and foreseeable future mining activities. Water programs were pursued in cooperation with the USGS Water Resources Division. These included continuation of several assessments of regional water resources for the State's hydrologic atlas. Assessments were also continued on the Vamoosa, Antlers, and Arbuckle aquifers. Hydrologic studies were begun in the coalfields of eastern Oklahoma to provide baseline data support for studies on the impact of surface coal mining on the subsurface water resources. Water quality in the abandoned zinc mines of the Miami-Picher area were studied at the instigation and with partial support of the Northeast Counties of the Oklahoma

Economic Development Association. The State Geological Survey also undertook a 5-year program under the auspices of the U.S. Nuclear Regulatory Commission (NRC) to study the seismicity and tectonic characteristics of the Nemaha uplift as part of the NRC's national studies of earth-crustal stability related to the installation of nuclear facilities. The Survey also provided support to other State agencies in identifying the criteria for safe disposal of urban, industrial, and hazardous wastes in sanitary landfill operations, for foundation problems, and for flood-prone areas.

In addition to the regular tasks of enforcing State health and safety regulations in mining operations, issuing permits for mining operations, and enforcing the required reclamation of surface-mined land, the Oklahoma Department of Mines strove to advance the development of miner training in health and safety practices, law, and application. The cause was aided by a grant from the Mining Enforcement Safety Administration (MESA). Training was provided by means of mobile training units that were sent to the mine site. The department was also active in supporting legislation to establish a system for reclaiming abandoned surface-mined lands. Outside the State, the department was a staunch supporter of the Interstate Mining Compact Commission.

The USGS, Water Resources Division, was active in the delineation of water resources, their quantity and their availability in the State. Many of the projects were conducted in cooperation with the Oklahoma Geological Survey. Oil and gas and mineral offices in Oklahoma City and Tulsa engaged in the study and evaluation of oil and gas and coal resources on Federal Government and restricted Indian lands, and in the operation and management of oil and gas wells and mines on such lands in the State of Oklahoma.

The Federal Bureau of Land Management (BLM) established a study team in Oklahoma to make an assessment of the environmental, economic, and social impact of coal mining in areas in which the Federal Government intended to lease coal resources.

A series of mining studies was pursued by Oklahoma State research organizations under contracts with the Federal Bureau of

Mines. Among the studies were those concerning development of a technique for controlling methane in gob areas, research and development of large-diameter drilling equipment, field testing of chemical injection for stabilizing coal mine roof rock, a mine ventilation study with pressure cycling, a cooperative project with the Oklahoma Geological Survey for the accumulation of data on the Hartshorne coalbeds in Haskell and Le Flore Counties, reduction of air pollutants from engines operated underground, conceptual design of automated longwall mining system, and study of an underground rubbilization and in situ retorting system for deep oil shale deposits. Some of these activities, though contracted in Oklahoma, were conducted at sites out of State.

Activities at the Bartlesville Energy Research Center of the Federal Energy Research and Development Administration (ERDA) centered around problems of oil and gas extraction, oil and gas utilization, advanced research and supporting technology, chemical and geophysical energy, and various others. The oil and gas extraction program related extensively to secondary and tertiary methods of oil and gas stimulation and measurement of the pertinent characteristics of oil and reservoirs. Oil and gas utilization studies concerned waste-oil recycling, oil identification, quality of crude oils and products, technology of refining processes, efficiency of energy use in engines, and alternative fuels. Among the advanced research projects were those concerning thermodynamics of coal liquids and characterization of syncrudes from coal. In addition, the center studied reduction of pollutants from engines operated underground and the evaluation of portable devices for gas detection for the Federal Bureau of Mines. Thermodynamic properties of organic compounds and fluids, automotive powerplant evaluation, and odorization of liquefied petroleum gas were also studied.

Employment and Wages.—Employment in the mineral industries is classified by the Oklahoma Employment Security Commission as oil and gas mining, other mining, and petroleum refining. Combined average monthly employment during 1976 in oil and gas mining and other mining was 41,642, about 4% higher than in 1975. Employment in petroleum refining in 1976

was 7,458. Oilfield workers earned an average of \$259 per week, accounting for total earnings of about \$538 million for the year. With average weekly earnings of about \$294, petroleum refinery workers had total earnings of about \$114 million in 1976. Wages and earning data for the mining of other materials were not separately compiled by the Employment Security Commission. Average individual earnings per week were highest in petroleum refining among 20 manufacturing and nonmanufacturing categories listed by the Commission. Average earnings for those employed in the field of oil and gas extraction were third, behind earnings for those employed in construction.

Transportation.—The tonnage of raw minerals and mineral products transported on the McClellan-Kerr Arkansas River Navigation System rose 193% above that of 1975. The U.S. Army Corps of Engineers, Tulsa District, reported that an increase in the quantity of petroleum products from 19,106 tons in 1975 to 666,970 tons transported in the Oklahoma part of the waterway in 1976 was due primarily to the massive shipments of petroleum products from the Ardmore refinery of Vickers Petroleum Co. to the Port of Muskogee by truck and then by barge to markets along the inland waterway. Shipments of coal were 191,484 short tons, up 14.1% from that of the previous year. Sand and gravel shipments were similar to those of 1975, totaling 124,525 tons. The Corps also reported shipments of 103,891 tons of stone. Stone and sand and gravel were moved internally within the Oklahoma portions of the waterway. Shipments of 63,252 tons of chemical fertilizer were about 23% less than in the previous year. Adding iron and steel, metal products, and other chemicals to the foregoing mineral materials brought the total of waterborne raw mineral materials and manufactured mineral products to 960,646 tons in 1976.

Significant additions to the pipeline network in the State of Oklahoma included the completion of the Seaway pipeline from Freeport, Tex., to the vicinity of Cushing in Payne County and a major intrastate, natural-gas pipeline by Oklahoma Natural Gas Co., which connected gasfields west and south of Purcell to the firm's major gas-storage facility near Depew in Creek County.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

The value of mineral fuels reached a record high of \$2.7 billion in 1976, surpassing that of the previous year by 23.5%. Values of coal, helium, natural gas, natural gas liquids, and petroleum increased, as did quantitative output of all fuel commodities except crude petroleum.

Efforts to expand the output of liquid hydrocarbons were supported by the drilling of 4,216 wells, about 16% more than in 1975. Total drilling footage was 22,037,047 feet, for an average of 5,227 feet per well. Osage County had the greatest number of completed wells (436), followed by Garfield (211), Okmulgee (183), Creek (155), Kingfisher (152), Stephens, Major, Beaver, Caddo, and Payne Counties.

Exploratory drilling had a success ratio of 45% for the 434 wells drilled, an increase of 40 wells and about 17% over that of 1975. The success ratio among field wells remained at 70%.

The number of drilling rigs recorded in the Hughes weekly national rig count is a standard index of industry activity. The weekly average in Oklahoma for 1976 was 183 active rigs, with an actual maximum of 227 active rigs in 1 week in November. Despite the extensive drilling, proved reserves of natural gas, crude oil, and natural gas liquids decreased during the year.

Leasing of mineral rights for future oil and gas exploration rose dramatically. The grand total value of bonus bids on leases offered for public sale in 1976 by the State, the Indian agencies, and the BLM was reported to be \$10.5 million, almost twice as much as in 1975. Total bonus bids received by the Commissioners of the Land Office for the State of Oklahoma in 21 lease sales involving 42,622 acres throughout the State was \$3,214,119.16. In an alltime-high bid in a sale by the Commissioners of the Land Office, W. M. Bryan, Inc., offered \$3,085 per net acre for a 70-acre tract in Grady County. Leases offered on restricted Indian lands drew a total bonus bid of \$7,261,721.11. The Anadarko Agency dominated the leasing of Indian lands with total bonus bids of \$3,144,499.86. Bonus bids on oil and gas leases held by the Osage Indian Tribe in Osage County were

\$2,109,085. A sale by the BLM brought a bonus bid of \$49,041.73.

A 27% increase in coal output in 1976 was accompanied by a 19% increase in the number of active mines and a 26% increase in the number of miners employed. The combined output of coal in Craig and Rogers Counties rose to 75% of the State's total.

Carbon Black.—Continental Carbon Co. prepared carbon black from liquid hydrocarbons at its plant near Ponca City in Kay County. Output decreased from that of 1975. The value of the product contrastingly rose compared with the value in 1975. Carbon black is an essential ingredient in the manufacture of heavy-duty rubber for application in tires, treads, conveyor belts, and other rubber products subject to extreme wear.

Coal.—The expansion of coal production witnessed in 1975 was accelerated in 1976 when the output of coal in the State was 3.6 million tons, an increase of 27% over that of the previous year. Value of the coal that was used or shipped was \$58 million, representing a 21% increase over the value in 1975. Unit value of shipped coal, however, dropped from \$16.69 per ton in 1975 to \$15.98 per ton in 1976, reflecting an increased production of coal for the generation of electric power and for industrial purposes and a relatively smaller proportion sold as metallurgical coal. The coal was mined in 10 counties in northeastern and eastern parts of the State. Together, Craig and Rogers Counties supplied 75% of the State's total output, followed in order by Le Flore, Okmulgee, Haskell, Nowata, Muskogee, Wagoner, and Latimer Counties. Craig County had the maximum output, some 2.1 million tons; and Latimer County had the least, about 13,000 tons. The Oklahoma Department of Mines reported that 49 companies held permits to mine coal during the year. These permits gave rise to 42 strip mines, of which 37 produced coal consistently. Employing 1,079 miners, some 26% above the number employed in 1975, the mines operated for a total of 222,319 man-days with a production rate of 16.3 tons per man-day, according to the State Department of Mines. A record for a single month's production

was established at Peabody Coal Co.'s No. 2 Rogers mine near Vinita in November, when the output exceeded 153,000 tons. Compensable, nonfatal injuries in the industry were held to 16; no fatalities occurred. New permits to mine coal were granted to 30 applicants, resulting in the establishment of 10 new operating mines. Of the 10 new mines, 2 had ceased production by the yearend, and 1 was destined to close in March of 1977. Of the remaining seven stable mines, two were in Craig County, utilizing the Crowberg, Fleming, and Iron Post coalbeds; one mine in Haskell County and one in Le Flore County were on the Stigler coalbed; two mines in Nowata County utilized the Fort Scott coalbed; and one was in Wagoner County on the Croweburg coalbed. These seven mines collectively accounted for 179,000 tons of the State's total coal production in 1976. Several small mines were closed during the course of the year, but the most significant mine to close was Peabody Coal Co.'s Rogers County No. 1 near Chelsea. Equipment from the No. 1 mine was moved to Rogers County No. 2 mine in Nowata County, where Peabody utilized four large shovels in the stripping and mining process.

Oklahoma coal was used extensively for generation of electric power in Missouri and Iowa. Metallurgical coal was shipped to Texas, Colorado, and foreign countries for the preparation of coke. Cement industries in Oklahoma and Texas used Oklahoma coal to fire kilns formerly fired with natural gas. Other markets to which coal was shipped on a contractual basis were in Illinois, Nebraska, Wisconsin, South Dakota, Arkansas, and Washington. Shipments to local customers in Oklahoma and those closely adjoining the State were by truck. Rail was used to carry large tonnages for generation of electricity to the Kansas City area and to steel industries in Texas and Colorado. A preliminary report by the U.S. Army Corps of Engineers, Tulsa District, specified that 190,000 tons of coal was shipped on the McClellan-Kerr Arkansas River Navigation System, principally to the Port of New Orleans for transshipment to steel industries in foreign countries. Coal shipments on the Oklahoma section of the Arkansas River Navigation System made up almost 11% of total shipments in that segment.

Surface Industries, Inc., subcontractors for Lone Star Steel Co., announced the closing of Lone Star's Pocahontas coal mine near Bache in Pittsburg County. The subcontractors stated that it had become impossible to operate the mine profitably in the face of union problems inherited from Lone Star Steel Co. The Howe Coal Co. preparation plant that had been purchased in 1975 by Zapata Fuels Co. was dismantled, shipped to Pennsylvania, and rebuilt in one of Zapata's operations there.

In cooperation with the Federal Bureau of Mines, the Oklahoma Geological Survey compiled data on the Hartshorne coal in Haskell and Le Flore Counties. The information included the position and logs of boreholes drilled by coal companies, the location and extent of the mined-out areas, and the configuration of the coalbed and its thickness. These data were used for preparation of structural contour maps and isopach maps. The Federal Bureau of Mines was involved in determining the methane content of the Hartshorne coal. A municipally supported study of the waters in abandoned underground coal mines beneath the city of McAlester revealed a reservoir reported to contain billions of gallons of water that is nonacid, has very little dissolved mineral, and has temperatures of 65° to 68° F. This water may be used for industrial and cooling purposes.

A segment of a State highway just east of Henryetta collapsed in June, resulting in a pit that was 30- to 40-feet long and 4-feet deep. The collapse was believed to have resulted from subsidence in an abandoned underground coal mine, of which there are many in the Henryetta area. As part of the State's program for reclamation of operating surface coal mines, the Chief Mine Inspector shut down one prominent coal mining company for failure to post bond for a new mining site.

The Oklahoma Department of Mines encouraged the development of a miner training program to comply with State and Federal requirements for preemployment mine training and training of employed miners in all aspects of mining techniques and safety. Planning and establishment of the program were assigned to Southeastern Oklahoma State University. The initial program of the training institute was conducted in conjunction with a training in-

stallation sponsored by Kerr-McGee Coal Corp. at its Choctaw mine in Haskell County. The program called for future establishment of State facilities for training.

Helium.—Helium was extracted at a Federal Bureau of Mines plant at Keyes. Output, which placed Oklahoma second among helium-producing States, was 243 million cubic feet of high-purity helium and 181 million cubic feet of crude helium, quantities that were respectively 8% and 22% greater than in 1975, and comprised 32% and 31% of the Nation's output. About three-fourths of the high-purity helium was extracted for the Federal Bureau of Mines programs relating to Government use and conservation of helium. Government-extracted helium, which has been priced uniformly since 1961 at \$35 per thousand cubic feet, was not competitive with helium produced privately, which sold at an average price of \$22 per thousand cubic feet f.o.b. plant.

Natural Gas.—For the first time since 1972, the production of natural gas increased compared with that of the previous year. Marketed production in Oklahoma in 1976 was 1,726 billion cubic feet, some 7.5% greater than in 1975. The gas had a total value of \$867 million, representing an increase of 68.7% above the value in 1975. Unit value of natural gas rose to 50.2 cents per thousand cubic feet from the unit value of 32 cents per thousand cubic feet the previous year. By December 31, 1976, there were 10,436 producing gas wells in the State, 667 more than on the same date in 1975. The Oklahoma Tax Commission recorded gross production tax payments in 64 counties for natural gas produced. Texas County led all counties with a production of 225 billion cubic feet of natural gas, followed by Beaver, Harper, and Dewey Counties. Major County, which had been third in 1975, dropped to fifth place in 1976. Oklahoma ranked third after Texas and Louisiana in the quantity of natural gas produced by individual States, accounting for 9% of the national production and 8% of the national value of marketed natural gas.

The American Petroleum Institute counted 790 successful gas wells drilled in Oklahoma in 1976 (table 5). Among these were 65 exploratory wells, including 7 in Caddo County, 5 in Grady County, and 4 each in Custer, Dewey, Pittsburg, and

Woods Counties. The Morrow and Springer strata of the Lower Pennsylvanian, and the Red Fork or Cherokee strata of the Desmoinesian stage of the Pennsylvanian, individually yielded the largest number of natural gas discoveries. The Morrow supported successful gas wells in Texas, Harper, Roger Mills, Beckham, Custer, and Dewey Counties, and yielded a calculated open flow of 89.6 million cubic feet of natural gas per day in the Cities Service Gas Co. No. 2 Hampey-A of Texas County. A Red Fork discovery in Roger Mills County yielded 3.7 million cubic feet of gas per day, and a Cherokee sand discovery in the same county had a calculated open flow of 4 million cubic feet of gas per day. Roger Mills, Custer, Canadian, Caddo, and Woodward Counties had a total of seven discoveries in the Red Fork and Cherokee. The Springer was found productive in five wildcats, yielding a maximum flow of 10.1 million cubic feet of natural gas per day in a well in Grady County. Other wells were found in Custer, Blaine, and Johnston Counties. The strata that had the most numerous discoveries were in the Anadarko Basin of the western part of the State. Multiple discoveries were also made in the Wapanucka Formation in Coal, Hughes, and Pittsburg Counties in the eastern part of the State, and in Hartshorne and Dutcher strata, and Mississippi lime or chat. The deepest producing zone discovered in gas wildcats was 16,244 to 16,254 feet in the Morrow in a well in Roger Mills County. The deepest discovered gas in the eastern part of the State was in a zone 10,190 to 10,369 feet in the Wapanucka Formation in Pittsburg County.

The number of successful gasfield well completions increased 23.7% in 1976 over the number completed in 1975. Forty percent of the 725 completed, successful gasfield wells were drilled in 7 counties including Canadian (56 wells), Beaver (49), Okmulgee (46), Pittsburg (40), Woods (35), Osage (33), and Caddo (32).

Total gas reserves in Oklahoma were 12.4 trillion cubic feet on December 31, 1976, according to the Committee on Natural Gas Reserves, American Gas Association. This represents a 5% net reduction of the reserves during the year.

Deliveries of natural gas to consumers in Oklahoma were 649 billion cubic feet in 1976. Electric utilities received 51% of the

delivered gas; industries, 29.4%; residential consumption, 12.6%; commercial consumption, 6.7%; and all remaining uses, 0.3%. Adding extraction losses, lease and plant fuel consumed, and fuel consumed by the pipelines, total consumption in the State was 812.2 billion cubic feet. The State received 1.246 trillion cubic feet of gas from other States by interstate pipeline and shipped 2.161 trillion cubic feet of gas to other States by pipeline, resulting in net deliveries of 915 billion cubic feet of gas to the interstate system.

As a result of an exceptionally cold January, delivery and supply problems developed for the distributors of natural gas. Oklahoma Natural Gas Co. (ONG) delivered 1.613 billion cubic feet of natural gas in 1 day in early January, establishing a new total gas delivery record for a 24-hour period in the State of Oklahoma. In the associated 7-day period, ONG also set a new record of 1.315 billion cubic feet average daily delivery. In the course of the same cold spell, Arkansas Louisiana Gas Co. (Arkla) lost line pressure and requested that gas be conserved in about 90 Oklahoma cities by the closing of the public schools. Beginning January 1 and extending at least until January 10, all industrial uses of natural gas as a raw material were curtailed. Arkla requested emergency purchase of 50 million cubic feet of gas per day from ONG to avoid further pressure drop and delivery curtailment. Cities Service Gas Co. called a complete halt to gas deliveries to many of its customers during the same period of time when the company was unable to supply 1 billion cubic feet of natural gas per day to their large consumers. Curtailments were applied down to quantities as small as 3 million cubic feet per month. Most of the firm's gas deliveries were in Oklahoma's neighboring States. Late in the year, the firm announced plans to increase gas storage capacity at its Webb natural gas storage field, west of Blackwell in north-central Oklahoma, by adding 10 new injection wells and constructing about 1½ miles of pipelines, to allow a peak deliverability of 270 million cubic feet. Lone Star Gas Co. was unable to provide 1 million cubic feet of gas per day to a new industry at Davis in Murray County where Lone Star is the normal supplier. By a complex fuel exchange, ONG provided natural gas to Mustang

Fuel Corp., which, in turn, delivered the natural gas to within 4 miles of Davis. Delivery was made to Davis via a pipeline constructed by the city. A potential shortage of natural gas needed to run irrigation pumps in western Oklahoma was discussed by Governor Boren and representatives of Southern Union Gas Co., Panhandle Eastern Gas Co., and Cities Service Gas Co., major natural gas suppliers in western Oklahoma. The firms assured the Governor that farmers would have sufficient natural gas to pump irrigation waters in the drought-plagued area. A fire at the natural gas processing plant of Dorchester Gas Producing Co. near Hooker in Texas County deprived Natural Gas Pipeline Co. of America of about 70 million cubic feet of natural gas per day. The Federal Power Commission ordered restoration of deliveries by Dorchester after repair of the plant. Facing gas shortages in the winter of 1976-77, Arkla announced a moratorium on new industrial customer commitments. The firm indicated that 55 industrial customers in a five-state area including Oklahoma would face cuts of 45% in natural gas supplies in the early part of 1977. Existing commitments to supply new plants under construction would be honored by the company. Future demands would be supported by a new contract to buy production out of the Spiro sand in eastern Oklahoma where Arkla would have access to new additional reserves of 20 billion cubic feet of gas with a capability of producing 10 million cubic feet per day.

Purchases of natural gas reserves and existing production in the latter half of the year indicate prices being paid for natural gas in the State of Oklahoma. Southland Drilling and Production Corp. started sale of natural gas to the Phillips Petroleum Co. gasline in Osage County at a contract price of 90 cents per thousand cubic feet of gas. Transok Pipeline Co. agreed to pay \$1.68 per thousand cubic feet of gas to Howard Engineering Inc. The gas obtained in wells about 6 miles southwest of Enid was for use by Public Service Company of Oklahoma. In August, Flynn Energy Corp. contracted to sell natural gas from five producing wells in Garfield County to Transok Pipeline Co. at a rate of \$1.50 per million Btu. It was reported that Flynn would install 10,000 feet of connecting pipeline and provide any com-

pression needed in the future. The five completed wells had a minimum total production capability of about 10 million cubic feet per day. The contract was to be renegotiated at the end of the year to obtain the best available price for the natural gas. In December, Oklahoma Gas and Electric Co. agreed to purchase as much as 2 million cubic feet of natural gas per day from each well drilled on a 6,000-acre tract held by NFC Corp. in the Ashland field in Pittsburg County. The price agreed on was \$1.60 per thousand cubic feet plus Btu adjustments, resulting in the highest price paid in the field. An annual escalation rate of 1 cent per thousand cubic feet would be applied for the 20-year term of the contract.

Gas shortages and curtailments which plagued the 1975-76 winter season recurred in December of 1976 when Lone Star Gas Co. interrupted service to schools and top-priority industrial customers for a period of 12 hours. The interruption, which took place in the service area in southern Oklahoma, affected about 29 towns in Oklahoma and Texas. Subsequently, ONG agreed to make 60-day emergency gas sales to Lone Star Gas Co. at a rate of approximately 50 million cubic feet per day priced at \$1.80 per thousand cubic feet, which was the residential price in Oklahoma. The source of ONG's gas for emergency sales was an unutilized supply that had been established to support three fertilizer plants scheduled to come onstream in 1977. Until that time, ONG would have an excess of about 62 billion cubic feet of gas per year for emergency sales in the interstate market.

Phillips Petroleum Co. renovated an 8-inch oil pipeline and extended it into Okmulgee, Okfuskee, and McIntosh Counties as a gathering system for natural gas produced in shallow wells. The short-term objective was to gather about 12 million cubic feet of gas per day, increasing with the aid of 12 boosters to about 31 million cubic feet per day. The line is connected directly to the Public Service Co. of Oklahoma's Riverside generating plant located southeast of Jenks in Tulsa County. Construction of the gathering system at an estimated cost of \$15 million to \$20 million was made possible by the existing high price of intrastate gas. Phillips Petroleum Co. also activated a new portion of its Osage County Natural Gas Gathering Sys-

tem to take about 4 million cubic feet of gas per day from about 28 wells in the South Dog Creek, Northeast Blackland, and Drummond oilfields. The line was equipped with two 580-horsepower compressors and a gas scrubber at Foraker. Between 1973 and 1976, the Osage System grew to 250 miles of pipeline and nine booster stations. ONG completed its \$18 million A-1300 pipeline system, which extends from storage caverns near Depew in Creek County about 72 miles to the vicinity of Purcell in McClain County. There, the 24-inch line is joined by two 20-inch pipelines. One extends northwest through Grady County and into Caddo County; the other extends from Purcell southward to Mayesville in Garvin County and eventually connects with gathering lines that serve Carter, Stephens, and Garvin Counties in southern Oklahoma. The \$18 million pipeline is the second largest pipeline project built by Oklahoma Natural Gas Co.

In a suit of several years' duration, in which plaintiffs alleged that Transok Pipeline Co. violated safety rules by laying a pipeline within 240 feet of rural homes, the State Supreme Court ruled that compliance with requirements of the welding code was insufficient adjudication of the issues presented. Rulings by the OCC to the contrary would have to be reversed.

Calorific Recovery Anerobic Process, Inc., planned to build a plant to recover methane gas, carbon dioxide, and traces of other gases released by bacterial action on feedlot manure. This plant, to be built near Hooker in Texas County, would have a capability of producing 3.5 million cubic feet of methane gas per day, which would be sold to Natural Gas Pipeline Co. of America at a rate of \$1.33 per thousand cubic feet. Agrico Chemical Co. started construction of a second fertilizer ammonia plant at its Tulsa Port of Catoosa installation. The production units are a 1,000-ton-per-day plant, a 630-ton-per-day nitric acid plant, and an 1,800-ton-per-day ammonium nitrate plant. A contract was previously negotiated with ONG to supply natural gas to the facility. Construction continued on two ammonia plants, one of which was a joint venture of Farmland Industries, Inc., and Agrico Chemical Co. at Enid, and the other, a project of W. R. Grace & Co. at Woodward. Natural gas

for these plants is to be supplied from part of ONG's unused reserve.

Natural Gas Liquids.—Increasing output of natural gas in 1976 was accompanied by a 5% increase in the output of all natural gas liquids compared with that of 1975. About three-fourths of the 42.5 million barrels of recovered natural gas liquids was liquefied petroleum gases (LPG), and the remainder was natural gasoline and cycle products. LPG accounted for about 71% of the \$254 million value of natural gas liquids. Oklahoma ranked third among the States that produced natural gas liquids. The American Petroleum Institute and American Gas Association ascertained that proved reserves of natural gas liquids in Oklahoma were 279.8 million barrels on December 31, 1976, a decrease of 6.5% from that of the previous year.

The commodity was recovered in 32 counties, according to the Oil & Gas Journal, at 82 natural gas processing plants. Expansion of the State's processing capability was anticipated during the year when Warren Petroleum Co. undertook a 50-million-cubic-feet-per-day expansion of its processing plant at Mayesville in Garvin County. Phillips Petroleum Co. entered the engineering phase for a 60-million-cubic-feet-per-day plant in Kingfisher County.

Texas Oil and Gas Corp. and ONG undertook construction of a natural gas processing plant near Woodward. The plant, having a capacity of 50 million cubic feet of gas per day, would cost \$4.75 million. It would be served by a 12-mile extension of an existing Texas Oil and Gas Corp. natural gas pipeline. The entire project was scheduled for operation by January 1977.

On recommendation of the LP-Gas In-

dustry Advisory Committee of the Federal Energy Administration, a Tulsa group undertook the study of the Nation's butane and propane requirements through 1980. Phases of the study treated worldwide supply and demand, importation, storage and fractionation, and distribution of imported liquefied natural gases.

Petroleum.—The crude oil industry in Oklahoma registered gains in almost all activities except the crucial one of quantity produced. Despite generous well production limits set at a rate of 200% of the allowable under the depth/acreage formula, total output of 161.4 million barrels of oil in 1976 was 1% less than that of 1975. Total value of the output increased contrastingly by 6.8% to \$1.5 billion. Oklahoma retained its fourth place among the States in production of crude oil.

Oil was obtained from 72,543 wells on December 31, 1976, a net increase of 967 wells above the number on December 31, 1975. The National Stripper Well Survey, a joint project of the Interstate Oil Compact Commission and the National Stripper Well Association, indicated that 73.5 million barrels of crude oil, or 46% of the State's total crude oil production in 1976, was from stripper wells, which numbered 53,357 at yearend. Because the high price of crude oil discouraged well abandonment, only 881 stripper wells were abandoned in 1976; 1,739 had been abandoned the previous year.

A net increase in the number of producing oil wells during the year resulted from vigorous drilling campaigns in established fields and in exploration. Field drilling resulted in completion of 1,921 successful oil wells, 237 more than in 1975. Osage County led all counties in the number of successful new field wells with 266, fol-

Table 4.—Oklahoma: Estimated proved recoverable reserves of crude oil, natural gas liquids, and natural gas

Commodity	Proved reserves Dec. 31, 1975	Changes in proved reserves due to extensions, revisions, and new discoveries in 1976	Proved reserves Dec. 31, 1976	Change from 1975 (percent)
Crude oil				
thousand 42-gallon barrels..	1,239,687	98,917	1,186,553	-4.3
Natural gas liquids -----do----	299,155	20,266	279,795	-6.5
Natural gas -----million cubic feet--	13,083,028	1,007,910	12,435,333	-4.9

Sources: American Petroleum Institute and American Gas Association.

Table 5.—Oklahoma: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Adair	--	--	--	--	--	1	1	2,025
Alfalfa	40	24	13	1	2	1	81	570,977
Atoka	--	--	--	1	--	--	1	875
Beaver	29	49	41	1	--	3	123	801,523
Beckham	--	7	--	--	1	1	9	186,126
Blaine	14	29	35	--	--	1	79	754,378
Bryan	50	32	18	3	7	11	121	1,379,639
Caddo	37	56	12	4	3	3	115	1,122,893
Carter	67	--	26	--	--	10	103	567,026
Cimarron	3	6	9	--	--	3	21	96,869
Cleveland	7	--	8	2	--	3	20	147,863
Coal	6	6	4	--	--	2	18	97,426
Comanche	19	6	7	1	--	1	34	44,076
Cotton	14	--	3	--	--	7	24	47,244
Craig	3	--	3	--	--	2	8	3,265
Creek	84	13	55	--	--	3	155	392,330
Custer	2	7	12	2	4	3	30	307,218
Dewey	39	17	29	1	4	13	103	1,010,650
Ellis	23	15	20	2	1	6	67	604,400
Garfield	163	14	22	5	--	7	211	1,400,509
Garvin	24	3	33	8	1	9	78	351,501
Grady	15	25	19	3	5	7	74	770,031
Grant	26	1	16	1	1	5	50	253,765
Greer	1	27	10	--	--	4	42	65,380
Harmon	--	--	--	--	--	1	1	9,075
Harper	4	22	20	--	1	3	50	329,006
Haskell	--	10	5	--	1	3	19	113,787
Hughes	25	22	12	1	--	2	62	174,711
Jackson	2	--	1	--	--	2	5	13,674
Jefferson	6	--	1	--	--	3	10	26,767
Key	25	13	19	2	1	9	69	225,523
Kingfisher	123	10	13	--	--	1	152	1,220,281
Kiowa	10	2	11	--	--	4	27	28,465
Latimer	--	7	4	--	--	1	12	130,275
Le Flore	--	14	5	--	1	--	20	165,080
Lincoln	16	2	36	1	2	16	73	321,143
Logan	62	8	22	9	1	8	110	597,841
Love	9	--	4	1	--	4	18	91,665
McCain	10	2	8	--	1	4	25	204,702
McCurtain	--	--	2	--	--	5	7	5,096
McIntosh	--	6	8	--	--	2	16	44,168
Major	81	25	15	1	1	1	124	984,248
Marshall	4	--	4	--	--	1	9	20,305
Murray	8	--	10	2	--	10	30	112,073
Muskogee	24	9	17	--	2	6	58	97,203
Noble	36	4	23	--	1	7	71	309,806
Nowata	36	1	11	--	1	3	52	48,882
Okfuskee	11	11	15	1	1	3	42	120,737
Oklahoma	11	1	12	1	1	4	30	175,182
Oklmulgee	75	46	56	1	1	4	133	385,192
Osage	266	33	124	1	--	12	436	971,943
Pawnee	30	2	17	4	--	7	60	168,534
Payne	65	3	37	5	1	10	121	521,301
Pittsburg	--	40	15	--	4	3	62	295,938
Pontotoc	52	2	17	--	--	3	74	152,733
Pottawatomie	26	--	13	1	1	6	47	217,530
Roger Mills	--	5	5	1	3	2	16	239,337
Rogers	7	--	3	--	--	1	11	7,557
Seminole	43	2	33	--	--	1	79	292,628
Sequoyah	--	5	--	--	--	1	6	32,487
Stephens	91	8	32	3	1	14	149	575,444
Texas	34	18	40	--	1	2	95	560,480
Tillman	1	--	--	--	--	1	2	8,128
Tulsa	18	1	4	--	1	--	24	38,609
Wagoner	--	--	3	--	--	1	4	4,130
Wagoner	16	1	9	--	--	3	29	36,336
Washington	1	--	1	--	1	2	5	61,693
Washita	18	35	26	--	4	6	89	525,444
Woods	3	18	27	--	3	10	61	474,362
Woodward	3	--	--	--	--	--	--	--
Total	1,921	725	1,136	70	65	299	4,216	22,037,047

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Table 6.—Oklahoma: Crude oil production, indicated demand, and stocks, in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within Oklahoma
January	13,329	11,033	17,605
February	13,960	14,789	16,776
March	13,884	14,488	16,172
April	12,596	13,196	15,572
May	14,028	12,610	16,990
June	13,267	14,785	15,472
July	13,460	14,041	14,891
August	13,374	13,424	14,841
September	13,656	14,506	13,991
October	13,562	11,465	16,088
November	13,184	13,055	16,217
December	13,126	14,512	14,831
Total:			
1976	161,426	161,904	XX
1975	163,123	160,768	XX

XX Not applicable.

Table 7.—Oklahoma: Crude petroleum production, by field
(Thousand 42-gallon barrels)

Field	1975	1976	Cumulative to Dec. 31, 1976
Allen	2,245	2,475	131,641
Bowlegs	1,245	900	160,637
Burbank	3,380	3,090	510,509
Cement	2,490	2,250	144,976
Cushing	2,670	2,580	468,432
Edmond, West	530	590	156,267
Eola-Robberson	3,150	2,730	113,357
Fitts	2,650	2,970	156,493
Glenn Pool	1,775	1,805	313,001
Golden Trend	6,190	5,485	413,686
Healdton	6,720	3,955	304,915
Hewitt	5,500	4,905	229,391
Oklahoma City	1,915	1,780	737,591
Seminole, Greater	880	910	201,246
Sho-Vel-Tum	32,600	31,465	1,066,521
Sooner Trend	9,140	9,550	218,104
St. Louis	970	995	218,110
Other fields	79,073	82,991	NA
Total	163,123	161,426	--

NA Not available.

Source: Oil and Gas Journal data adjusted to Bureau of Mines total.

lowed by Garfield (163), Kingfisher (128), and Stephens (91). These completions accounted for 34% of the successful field wells drilled in the State during the year. Other significant drilling occurred in Creek, Major, Okmulgee, Carter, Payne, and Logan Counties, with the 10 named counties having 56% of all successfully completed field oil wells.

Although crude oil was produced in 63 counties, more than 40% of it was recovered in Stephens, Carter, Osage, and

Garvin Counties, where the output was 23.9 million, 20.3 million, 10.8 million, and 10.4 million barrels, respectively. Kingfisher, Texas, Grady, Caddo, Creek, and Seminole Counties followed in order. Total output in the top 10 ranking counties was 105 million barrels, or more than 65% of the State's total output. Value of the oil produced in these counties was 61% of the State's total crude oil value.

The number of successful exploratory oil wells increased from 59 in 1975 to 70

in 1976. Successful exploratory drilling took place in 30 counties. Half of the State's successful wells were in six counties. Logan County had nine operations; Garvin, eight; Garfield and Payne, five each; and Canadian and Pawnee, four each. Except for Garvin County, the listed counties are situated essentially in central and north-central Oklahoma.

Productive strata encountered were most commonly those of the Pennsylvanian, including Layton, Cleveland, and Skinner sands, the Mississippian lime or chat, the Hunton of the Devonian, and the Wilcox of the Middle Ordovician. Producing zones were generally shallowest in Pawnee and Garvin Counties. In Payne County, Layton pay was found at 3,089 feet, but one pay in the Mississippian was in a zone perforated between 4,904 and 5,004 feet. In Logan County, the Oswego was opened at 5,234 feet in one well but the deepest Mississippian pay was opened at 5,682 to 5,958 feet. Producing zones in the Mississippian in Garfield County discoveries were encountered at 5,470 feet and 5,638 feet, with perforations extending to 6,052 feet. Deepest drilling in the active counties was that in Canadian County, where Hunton strata were perforated between 7,229 and 7,284 feet; and Lower Skinner, perforated between 7,490 and 7,496 feet, was comingled with oil from the Mississippian recovered between 7,924 and 7,963 feet. No oil was discovered in the eastern quarter of the State, and almost none in the western part of the State. One exploratory well discovered oil in the Pennsylvanian in Love County. Exploration in most of the other southern counties was essentially fruitless.

Apparent maximum oil production from exploratory wells was obtained in the Golden Oil Co. No. 1 Barnard Ranch, the discovery well in the South Dog Creek field in Osage County, where the Mississippian chat perforated between 2,530 and 2,546 feet; the well flowed 218 barrels of oil per day through a $\frac{1}{8}$ -inch choke. Golden Oil Co.'s No. 11 Osage, drilled in the same oilfield, flowed 460 barrels of oil on a $5\frac{1}{2}$ -hour test. With an estimated daily production of 2,008 barrels of oil, this well and South Dog Creek field were outstanding developments in the Osage. Ethyl Corp.'s No. 1 Bailey, the discovery well for the Southwest Mutual field in Dewey County, flowed 25 barrels of oil per hour

through a $\frac{3}{8}$ -inch choke from the Red Fork. The computed daily rate was 600 barrels of oil per day, with 1.2 million cubic feet of gas per day in addition.

The quantities produced by new oil wells, extensions, and revisions failed to keep pace with withdrawals during the year. Proved reserves of crude oil declined from 1,240 million barrels at the beginning of 1976 to 1,187 million barrels at yearend.

In January, about 40 oil wells in East Binger oilfield in Caddo County were producing 2,500 barrels of crude oil per day under an allowable of 133 barrels of oil per day per well. Subsequently, the OCC ordered reduction of the allowable to 100 barrels per day per well because of potential decline of field gas pressure and loss of gas produced with the oil and possible future unitization. Production on wells more than 1 year old was reduced in October to 10 barrels per day, and wells that were less than 1 year old were put on a scheduled quarterly reduction of oil produced that would allow each well a total output of 36,500 barrels of oil in the first year. Operators of the field failed to agree on a method of secondary recovery for the field by yearend, and several had filed suit against the OCC, thus temporarily halting the Commission's attempt to further regulate the field. During the year, Phillips Petroleum Co. constructed a 20-mile natural gas pipeline to carry casinghead gas from Binger field to the firm's gas-treating plant at Norge field near Chickasha, and Pioneer Gas Products completed a natural gas processing plant in the Binger area.

Hemphill Corp. of Tulsa undertook plugging of about 28 oil and gas wells in the vicinity of Birch Lake, a project of the U.S. Army Corps of Engineers under construction in Osage County. Phillips Petroleum Co. continued injection of a brine, alcohol, and sulfonate surfactant into its 90-acre experimental tertiary recovery project in the North Burbank oilfield near Shidler. The experiment was part of a cooperative research program with ERDA. An independent oil operator was attempting to reestablish the production of oil in an area about 4 miles north of the town of Foyil in Rogers County. The area had been strip mined for coal, and old oil wells had been pulled and plugged. New wells were being drilled on a five-spot pattern to allow waterflooding of the Bartlesville

sand that had not been previously flooded at that locality. Gulf Energy and Minerals Co., completed 13 wells for the application of a microemulsion (micellar-polymer) tertiary recovery project in the Glenn Pool in Creek County. The company was also involved in the drilling of 13 additional wells to test a steamflood tertiary recovery system. Both tests covered individual 20-acre tracts and the underlying productive Glenn (Bartlesville) sand. The company anticipated a 4-year test period starting in 1977. Under the operation of Sun Oil Co., plans to bring the Norge-Marchand unit in Grady County to full production approached fruition. This included the final installation of 63 producing wells and 25 water-injection wells. Maximum expected daily production from the unit was about 7,000 barrels of oil per day from the Marchand formation. The fire flood set by Continental Oil Co. in a heavy oil formation 250 feet from the surface, near Loco in Stephens County, began to recover heavy oil at a reported rate of 34 barrels per day. Production of oil from the fire flood, which covered a 75-acre tract, involved numerous technicalities, including use of anticorrosion materials in the casing, mixture of deemulsifying chemicals and continued experimentation with the rate of injection of air and flooding water, and the rate and time of pumping on collection wells. Continental also installed a steamflood experiment on 20 acres in the same viscous oil formation.

The need for conserving energy and protecting the environment caused Sun Oil Co. to modify operations at its Tulsa refinery and petroleum products plant. About 43 storage tanks, each holding 7,000 to 55,000 barrels of edible and nonedible wax made from petroleum, were scheduled for insulation. The insulation was required to reduce heat loss from steam that is circulated around the tanks to maintain wax in a fluid state. Bottom loading facilities were installed at the Sun Oil refinery's gasoline tank-truck-loading terminals to reduce hydrocarbon emissions in the loading of the trucks. Adaptation of tank trucks to bottom loading cost approximately \$3,000 per truck.

Continental Pipeline Co. replaced its pipeline crossings beneath the Arkansas River near Jenks. The old pipelines, laid in the 1930's, had been made with acety-

lene welds that are subject to deterioration. In addition, construction of Keystone Dam upriver had reduced sediment transport in the river and bottom scour tended to expose the old pipelines in the bed of the river. Seaway Pipeline Co., with pipeline from Freeport, Tex., to Cushing, Okla., delivered the first oil to Cushing on November 13. Storage at the Cushing end of the pipeline included nine tanks capable of holding 2.7 million barrels of crude oil. Bigheart Pipeline Corp. expanded its gathering system in Osage County to the South Dog Creek field to accept oil being produced at that point.

Hudson Oil Co. of Kansas City, Kans., purchased the Cushing plant of Midland Cooperatives, Inc. Hudson announced that the plant would be enlarged from a capacity of 19,000 barrels per day to 40,000 barrels per day to supply Hudson outlets in 35 States. Though the refinery had previously suffered from a lack of domestic crude oil and inability to obtain foreign crude oil, the completion of both the Seaway and Texoma pipelines brought a dependable supply of crude oil to Cushing. Sun Petroleum Products Co. completed installation of a unit to produce cyclohexane at its Tulsa refinery, with initial output of 42,000 gallons of cyclohexane per day. The firm planned eventual expansion of the output to 85,000 gallons per day. Conversion of the existing refinery reforming unit to allow the production of cyclohexane took 6 months and cost \$2.5 million. Sun also announced that the Tulsa refinery had been licensed to use Exxon Research and Engineering Co.'s DILCHILL process for dewaxing lubricating oil. Planned completion of the installation in 1978 would increase production of lubricating oil about 35% compared with 1976 capability. Difficulties encountered in starting up Vickers Petroleum Corp.'s Ardmore refinery after enlargement were overcome by August 1, when the plant achieved its rated capacity of 60,000 barrels of crude oil per day. Texaco, Inc., awarded a contract to Williams Bros. Waste Control, Inc., a subsidiary of the Resource Science Corp., for the basic design and development of a wastewater-treatment facility for the Tulsa refinery. The facility would meet all foreseeable needs of the refinery. Bareco Div., Petrolite, Inc., decided in early 1976 to close its Barnsdall wax plant by mid-1977,

but later countermanded the decision pending studies of Bareco's other facilities and the position of the company in the economics of the community. The plant was scheduled to remain active at least through 1978. The original decision to close the facility was based on the inability to obtain locally those raw materials that had been available when the plant was built in 1910.

APCO Oil Corp. was actively seeking purchasers for the assets of the company under an established plan of liquidation. A plan was devised to merge Tulsa-based Skelly Oil Co. into the Getty Oil Co. Mission Corp. would also be included in the merger. The deal, which involved \$356 million, was scheduled to be consummated in early 1977.

Under a grant from the American Gas Association, chemical and petroleum engineers at the University of Tulsa continued investigations into methods of reducing friction in gas transmission systems. The research follows the concept of reducing friction by adding a liquid to the two-phase gas-liquid mist commonly present in natural gas lines. A study of the Wheatley rotary pump for pipeline pumping was also conducted by mechanical engineering students and researchers. In concept, the continuous forward motion of the rotary pump would eliminate the internal resistance developed in a conventional piston pump as applied to pipeline transmission.

NONMETALS

Boron.—Eagle-Picher Industries, Inc., and ERDA entered into an agreement that extends to 1982, under which the firm would produce Boron-10 metal for the agency. Plant modifications and new installations at the firm's Quapaw plant will be paid by Eagle-Picher. ERDA will pay the firm more than \$90 million in facilities charges and production costs. The firm's early fees and profits came from a cost-plus arrangement that was later supplanted by a fixed-price incentive contract. Boron-10 is used in nuclear reactors as an absorbent for neutrons.

Cement.—The cement industry recovered from its 1975 decline as the quantity of cement sold or used increased 26% for masonry cement and 9% for portland cement in 1976; the value of the cement

increased 22% compared with that of 1975. Portland and masonry cement prepared at each of the three plants in the State included both white and gray varieties adjusted for general-purpose-moderate-heat, high-early-strength, very-high-sulfate-resistance, oil-well, and waterproof use requirements. Portland cement was sold to the following types of users: Building material dealers (10%), concrete product manufacturers (9%), ready-mixed concrete companies (58%), highway contractors (13%), other contractors (7%), Government agencies (less than 0.1%), and miscellaneous users (3%). Eighty percent of the cement was shipped by truck; 16%, by rail; and 4%, by barge. Bulk handling was applied to 93% of the shipped cement and the remainder was in containers. Manufacturing required 2.7 million tons of raw materials, including 2.2 million tons of limestone, the basic substance used in all plants. The remainder included clay, bauxite, shale, sand, iron ore, and gypsum. Requirements in 1976 exceeded those in 1975 by 13%. The industry operated four dry-process kilns equipped with glass bag dust collectors and two wet-process kilns with electric dust precipitators. Plant operations in 1976 consumed about 92,000 billion Btu of energy, which was supplied by 6.1 billion cubic feet of natural gas, representing 68% of all the energy used. Electricity used totaled 196.2 million kilowatt-hours, accounting for 22% of the energy. The remaining 10% came from coal, which was used for the first time in a modern cement plant in Oklahoma. Total energy consumption was about 5% higher than in 1975, but consumption of natural gas was reduced about 10%. Ongoing activities at the Ada plant of Ideal Basic Industries, Inc., and the OKC Corp. plant in Pryor to convert them to the use of coal presaged a further drop in the use of natural gas in the future and increase in the importance of coal to the industry.

Clays.—Despite production of 1.2 million tons of clay and shale in 1976, about 16% higher than in 1975, the value of clay reported at \$1.7 million was 1% less than that of the previous year. Clay and shale was mined in 11 counties, scattered through which were 15 individual operations of 12 separate companies.

Canadian, Pontotoc, Rogers, and Oklahoma Counties accounted for 74% of the

clay and shale mined and 64% of the value. The combined production of Acme Brick Co., Chandler Materials Co., Ideal Cement Co., and Oklahoma Brick Corp. represented 74% of the State's total quantity and 67% of the State's total clay and shale value. Manufacture of face brick utilized 46% of the clay; cement required 34%. Other products, in order of decreasing requirements for clay and shale, were concrete block made from lightweight aggregate, structural concrete of the same nature, sewer pipe, common brick, and pottery. United Clay Pipe Co. of Seminole, whose 1975 activities had been reduced to the manufacture of clay pots, ceased operation because of financial difficulties and mined no clay or shale in 1976.

Because most brick and structural clay products manufacturers sold their products in relatively localized areas, the majority of shipments was by truck. One manufacturer of clay and cement brick with an established regional market depended heavily on rail transport, both for receipt of raw materials and additives and for distribution of product.

Feldspar.—About 25% of the glass sand recovered by Arkhola Sand & Gravel Co. at Muskogee from the Arkansas River consists of feldspar. This feldspathic sand is used locally in the manufacture of glass jars. Increase in the amount of feldspar produced in 1976 over that of 1975 was commensurate with the increase in the amount of glass sand produced by Arkhola.

Gypsum.—Oklahoma maintained its fifth place among gypsum-producing States by virtue of increases of about 9% in quantity and 20% in value of produced crude gypsum, compared with 1975 production. Output was about 1 million tons valued at about \$5.8 million. Just over one-half of the State's total output of crude gypsum was produced in Blaine County, where three firms mined 640,000 tons of gypsum. The remainder was obtained from mines in Jackson, Comanche, Caddo, and Canadian Counties. United States Gypsum Co., followed in order by Republic Gypsum Co. and United States Steel Corp., led the seven firms that operated gypsum mines in the State. Gypsum was mined by surface method from Permian formations that are widespread throughout the western part of the State. The Blaine Formation was mined in Blaine, Canadian, and Jackson

Counties, and the Cloud Chief Formation was the source in Caddo and Comanche Counties.

Gypsum was calcined by United States Gypsum Co. and Republic Gypsum Co. Output in 1976 was 17% above that of 1975. The value, however, was 1% less than in 1975. United States Gypsum Co.'s plant at Southard in Blaine County ranked fourth nationally in the production of calcined gypsum. Gypsum was sold in the State as an agricultural soil conditioner. The calcined material was used in plaster and in the manufacture of prefabricated building materials such as wallboard, and United States Steel Corp., Universal-Atlas Cement Div., mined the gypsum for use as a retarder in cement. Except for the gypsum used in agriculture and that calcined at plants at Southard in Blaine County and Duke in Jackson County, most of the gypsum was used or processed outside of the State.

Iodine.—Construction of Houston Chemical Co.'s (PPG Industries, Inc.) iodine extraction plant north of Woodward progressed toward completion and operation was scheduled for early 1977. Amoco Production Co. was engaged in drilling and completing 14 wells to Morrow strata at a depth of 7,000 to 7,500 feet for a system to withdraw iodine-bearing brines for processing in the plant and through which to dispose of stripped brines by reinjection into subsurface strata. Plant capacity was established at about 2 million pounds of iodine annually.

Lime.—Output of lime by St. Clair Lime Co., the State's only lime producer, increased 9% in 1976 over that of 1975. Value of the output increased 22%. Limestone from the firm's underground mine in the Silurian Quarry Mountain Formation was converted at its plant near Marble City, Cherokee County, to quicklime and hydrated lime. The plant had two kilns, one of which was shut down in the latter part of the year for installation of a stack dust-collecting system to bring it into compliance with the State's air quality standards. Lime was sold for use as a soil stabilizer, to control acidity in agricultural soils, and for chemical applications. Shipments of lime sold or used by producers to destinations in Oklahoma in 1976 were 76,980 tons of quicklime, 23,134 tons of hydrated lime, for a total of 100,114 tons.

Pumice (Volcanic Ash).—Volcanic ash was mined by Axtell Mining Corp. at one site near Gate in Beaver County. The value of the company's product, prepared locally for use as soft abrasives and other purposes, increased 67% in 1976 over that of 1975. Studies by the Oklahoma Geological Survey suggest that the ash deposits are windblown volcanic dust that collected in lakes during the Pleistocene. Similar deposits have been identified in several other localities in Oklahoma.

Salt.—Both salt brine and crystalline salt evaporated from brine were produced in Oklahoma in 1976. The combined output of Acme Salt Co. in Harmon County and Blackmon Salt Co. in Woods County was 22% higher than that of 1975, with a commensurate increase of 20% in value. To obtain crystalline salt, brine collected from natural springs and drilled wells is evaporated in shallow solar pans. The brine originates as percolating groundwater that penetrates and dissolves salt in the near-surface Flowerpot Formation of Permian age. According to the State Geological Survey, produced salt contained about 98% sodium chloride, 1.8% gypsum, and a fraction of a percent of silica that was blown into the solar evaporating pans. Brines are used as drilling fluids in oil and gas well drilling, and the salt is sold for stockfeed, as a recharger for zeolite-charged water softeners, and as a road deicer.

Sand and Gravel.—Both the quantity and value of produced sand and gravel rose for the second consecutive year in 1976. Output recorded at 10 million tons was 4.7% greater than in 1975, but its correlative value of \$19 million was 13.7% larger.

The materials were mined in 45 counties by 106 producing firms with 133 separate operations. Tulsa, Oklahoma, Johnston, and Muskogee Counties, led by Tulsa County with an output of 2.1 million tons, each produced more than 0.5 million tons

and collectively supplied 48% of the State's total output. Six firms with operations at 17 sites produced 40% of the sand and gravel. Among these firms were Arkhola Sand & Gravel Co., The Dolese Co., E & A Materials, Inc., Mohawk Rock and Sand Co., Pennsylvania Glass Sand Corp., and Shoffner Sand of Oklahoma, Inc. General increases in both the quantity and value of sand and gravel produced for construction and industrial purposes were recorded. Increases were noted in the amount of sand and gravel used in concrete products, asphaltic concrete aggregates and other bituminous mixtures, roadbase and coverings, and fill. Decreased quantities of sand and gravel sold or used for concrete aggregate, (residential, nonresidential, highway, bridge, dam, waterwork, airport, and other construction) and for a variety of other uses. The largest tonnage gain in quantity was 460,000 tons or 29.7% recorded for fill. The largest percentage gain was 71.4% (410,000 tons) recorded for concrete products. Losses of 157,000 tons (3.8%) and 598,000 tons (62%) were experienced by concrete aggregate and other uses, respectively. These changes roughly parallel losses and increases experienced by crushed stone in 1976, and appear to be related to a decrease in heavy construction, as discussed in the section on stone.

With an output of 1.3 million tons, industrial sand was 13% of the total sand and gravel produced in the State in 1976 and 18.5% greater than output in 1975. Five firms produced industrial sand, which was mined in Johnston, Muskogee, Pontotoc, and Tulsa Counties. The products included ground and unground sand. Ground sand was used as a filler in the preparation of enamel ware, glass, pottery, porcelain, and tile, for the manufacture of glass, as foundry sands, and as abrasives. Unground sand was used in foundry molding, manufacture of glass, as engine sand and blasting sand, and for the treatment of oil formations in the hydrafrac process.

Table 8.—Oklahoma: Sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Construction:				
Sand	(¹)	(¹)	7,435	9,101
Gravel	(¹)	(¹)	1,326	2,874
Total ²	8,512	11,109	8,760	11,975
Industrial:				
Sand	1,078	5,640	1,277	7,075
Grand total ²	9,591	16,749	10,037	19,050

¹ Data for 1975 not available on the same basis as that for 1976.

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

Table 9.—Oklahoma: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	4,114	6,649	3,957	6,356
Concrete products (cement blocks, bricks, pipe, etc.)	574	946	984	1,841
Asphaltic concrete aggregates and other bituminous mixtures	286	609	374	784
Roadbase and coverings	1,026	822	1,072	1,103
Fill	1,547	964	2,007	1,660
Other	965	1,119	367	281
Total	8,512	11,109	8,760	11,975

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

Most of the sand and gravel for construction was recovered by pumping from beds of major streams such as the Arkansas, Canadian, and Cimarron Rivers, and other streams throughout the State. The commodity is also extracted from flood plains of streams and upland terrace deposits. A large portion of the industrial sand was recovered by hydraulic mining of the poorly consolidated Simpson Sands of Ordovician age in Johnston and Pontotoc Counties. Industrial sand was also recovered from the bed of the Arkansas River at Muskogee and Tulsa.

Because of the low value of sand and gravel and its widespread distribution throughout the State, the commodity is commonly purchased at local sources and transported to consumer by truck. By virtue of their unique physical and chemical characteristics, glass sands enjoyed both local and national markets. Transportation

to the more distant consumers was by rail. Trucks hauled about 89% of the sand and gravel shipped in the State. Average shipping distances reported by producers ranged from 1 to 12 miles, and costs ranged from 4 to 20 cents per ton-mile, with a majority reporting 5 to 6 cents per ton-mile.

Manufacture of flat glass at Ford Motor Co.'s Tulsa glass plant was interrupted twice during the year. A severe rainstorm and flood in June put one production line out of operation for a week. Collapse of the plant roof over the other production line shut it down for approximately 1 month. The plant was again shut down in September in conjunction with a nationwide strike of Ford plants by the United Auto Workers. Furnaces were maintained on standby during the period of the strike by skeleton crews. The plant, which is capable of manufacturing 1 million square

feet of float glass per day, employs 720 workers. Most of the glass is used for architectural purposes. Early in the year, Midland Glass Co. started modifications on their newly acquired glass plant in Henryetta from the manufacture of flat glass to the manufacture of bottles and other containers. The plant was subsequently opened and staffed with a labor force of about 250 persons. Appraisers for the Federal Government found that the value of remnant sand and gravel in the bed of the Arkansas River between Muskogee, Okla., and Fort Smith, Ark., and owned by the Choctaw, Cherokee, and Chickasha Indian Tribes is \$5.7 million. The total value of sand and gravel, past and present, assigned to the ownership of the Indians by Federal appraisers is \$27 million.

Stone.—The State's output of stone, reported as 19.6 million tons, was about 2.4% less in 1976 than that of 1975, apparently due to a decline in heavy construction. Value of stone output, having increased by 1.4% above that of the previous year to \$37.3 million, was 1.3% of the total value of Oklahoma's raw mineral product in 1976. Limestone was quarried most extensively; dolomite, sandstone, and granite were produced in minor quantities. More than 99% of the stone was crushed. The remainder, mostly granite, was dimension stone, riprap and jettystone.

Tulsa and immediately surrounding counties were the source of 35.4% of all stone quarried. Counties in the vicinity of the Arbuckle and Wichita Mountains in

the southcentral and southwestern parts of the State provided 41.6% of the quarried stone, including all granite and dolomite. The remaining 23% of produced stone was primarily from the eastern half of the State. Production of more than 1 million tons was achieved in six counties, led by Tulsa with 3.8 million tons, and followed successively by Murray, Comanche, Kiowa, Rogers, and Pontotoc Counties. The combined stone output in these six counties was 61.5% of the stone quarried in Oklahoma in 1976.

Crushed stone was produced for many purposes by 35 companies at 59 quarries. Production for leading uses included 5.9 million tons for concrete aggregate, 4.8 million tons for dense-graded roadbase, and more than 1 million tons each for cement manufacture, bituminous aggregate, surface treatment aggregate, and railroad ballast. Output of stone for dense-graded roadbase, cement manufacture, and bituminous aggregate represented substantial quantity and percentage increases from that of 1975. Concrete aggregate experienced the greatest loss in output, followed by railroad ballast, surface treatment aggregate, riprap and jettystone, and roadstone. Crushed stone was sold for glassmaking, a use not recorded in 1975. Total production of crushed stone in 1976 was 2.3% less than that of the previous year.

Clues to changed use patterns are found in the monthly summary of Oklahoma business compiled by the Center for Economic Management and Research at the

Table 10.—Oklahoma: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975		1976	
	Quantity	Value	Quantity	Value
Dimension:				
Limestone ¹ -----	W	W	W	W
Granite -----	W	W	W	W
Total -----	21	1,007	10	709
Crushed and broken:				
Limestone ¹ -----	19,220	34,342	18,750	34,743
Other stone ² -----	870	1,490	875	1,887
Total -----	20,090	35,832	19,625	36,630
Grand total -----	20,111	³ 36,840	19,635	37,339

W Withheld to avoid disclosing company proprietary data; included in "Total."

¹ Includes dolomite.

² Includes granite, sandstone, and chert.

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

Table 11.—Oklahoma: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate -----	6,452	11,950	5,902	11,980
Dense-graded roadbase stone -----	4,298	6,367	4,831	6,990
Cement manufacture -----	1,932	2,712	2,323	3,137
Bituminous aggregate -----	1,555	2,817	1,674	3,471
Surface treatment aggregate -----	1,543	3,993	1,338	3,767
Railroad ballast -----	1,390	2,124	1,017	1,488
Riprap and jettystone -----	1,079	1,725	878	1,726
Roadstone -----	827	1,539	643	1,183
Agricultural limestone -----	397	712	448	827
Glass -----	--	--	157	W
Macadam aggregate -----	235	257	99	148
Asphalt aggregate -----	21	65	32	W
Filter stone -----	1	1	W	W
Other uses ² -----	361	1,566	283	1,963
Total ³ -----	20,090	35,832	19,625	36,630

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

¹ Includes limestone, sandstone, miscellaneous stone, and granite (1975).

² Includes lime manufacture, fill, mineral food, bedding material, roofing granules, and uses indicated by symbol W.

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

University of Oklahoma. The State's total construction contract awards of \$1.5 billion in 1976 exceeded those of 1975 by 15%. However, nonresidential contract awards (\$404.4 million) and nonbuilding contract awards (\$365.2 million) declined 4% and 2%, respectively, from awards in 1975. The value of contract awards for residential construction (\$705.7 million) increased concurrently by 45%. Despite relatively high growth of residential construction, the contractual losses in heavy construction (a concrete intensive industry) apparently were a dominant factor in reducing stone output in 1976.

About 86% of the crushed and broken stone was shipped by truck. Railroads accounted for 8% of the shipments. The remaining 6% of the stone was transported by other methods. Shipments by rail were made from Atoka, Comanche, Johnston, Murray, Ottawa, Sequoyah, and Tulsa Counties. Murray County led in rail shipments of crushed stone, followed by Ottawa County with rail shipments of limestone and chat, the crushed rock residues from zinc ore mining and milling.

Output of dimension stone was 9,635 tons in 1976, 53% less than in 1975. Value of the stone was \$709,000. Granite was quarried in Comanche, Greer, Johnston, and Kiowa Counties. Operations of six firms included eight quarries. Limestone was quarried as irregular stone at one site in

Johnston County. Granite products included rough blocks, monument stone, and finished monuments. Rough blocks and monument stone were shipped to several large nonmonument works on the U.S. eastern seaboard as well as to local works.

Homeowners in Tulsa and Rogers Counties confronted Anchor West Materials Co. and Tulsa Rock Co. with legal actions to curtail or prohibit quarrying near homesites. Teamsters and operating engineers in Oklahoma City struck three of the city's large suppliers of ready-mixed concrete and drastically slowed heavy construction there during June and July.

Sulfur.—Sulfur was recovered as a result of natural gas processing and petroleum refining at three plants. Pioneer Gas Producing Co.'s natural gas processing plant at Madill, Sun Oil Co.'s refinery at Duncan, and Texaco's West Tulsa refinery were the producers.

Tripoli.—The commodity was mined from shallow lenticular deposits in the Boone Formation of the Mississippian system in Ottawa County by American Tripoli Co., a division of The Carborundum Co., and Midwestern Minerals Corp. Raw tripoli was processed by American Tripoli Co. of Seneca, Mo. Production of the pulverulent, porous, microcrystalline silica used to make fine-grained abrasives increased 132% in 1976 over that of 1975. Value of the product increased 82%.

METALS

Lead and Zinc.—The only sale of metal ore by a mining company in Oklahoma in 1976 was that of zinc and lead ore by Eby Mining Co. The Oklahoma Department of Mines reported that the ore was derived from cleanup operations on waste and tailings piles in Ottawa County and not from underground mining operations. National Zinc Co. completed its electrolytic zinc refinery at Bartlesville and began operations in June. Using an advanced Vielle

Montagne process for the first time in the United States, the plant has the capacity to produce 51,000 tons of zinc per year.

Uranium.—Union Carbide Corp. undertook sampling of surface and ground water as well as stream sediments in a search for uranium resources. The program is part of ERDA's national uranium resource assessment.

Kerr-McGee Corp. continued expansion at its Sequoyah facility near Gore to increase its capacity to prepare uranium hexafluoride.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon black:			
Continental Carbon Co ----	Box 22085 Houston, Tex. 77027	Furnace -----	Kay.
Cement:			
Ideal Basic Industries, Inc. ^{1,2}	420 Ideal Cement Bldg. Denver, Colo. 80202	Quarry and plant -	Pontotoc.
Martin Marietta Cement Corp., Western Div. ^{1,2}	5350 East 46th St. Tulsa, Okla. 74135	----do -----	Rogers.
OKC Corp. ^{1,2} -----	Box 68 Pryor, Okla. 74361	----do -----	Mayes.
Clays:			
Chandler Materials Co ----	Box 627 Tulsa, Okla. 74101	Mine and plant ---	Oklahoma and Rogers.
Commercial Brick Corp ----	Box 1382 Wewoka, Okla. 74884	----do -----	Seminole.
Justin Industries Acme Brick Co.	Box 425 Fort Worth, Tex. 76101	----do -----	Canadian, Custer, Oklahoma, Tulsa.
Oklahoma Brick Corp ----	Box 87 Union City, Okla. 73090	----do -----	Canadian.
Coal:			
Bill's Coal Co., Inc -----	Route 1 Welch, Okla. 74369	Strip mine -----	Craig and Wagoner.
Garland Coal & Mining Co.	Box 186 Fort Smith, Ark. 72901	----do -----	Haskell and LeFlore.
Leon's Coal Co -----	Route 1 Bluejacket, Okla. 74333	----do -----	Craig.
P & K Coal Co -----	Box 550 Henryetta, Okla. 74437	----do -----	Oklmulgee.
Peabody Coal Co -----	301 North Memorial Dr. St. Louis, Mo. 63102	----do -----	Craig and Rogers.
Gypsum:			
Harrison Gypsum Co., Inc.--	Box 336 Lindsay, Okla. 73052	Quarry -----	Caddo.
Republic Gypsum Co ----	1100 Mercantile Bank Bldg. Dallas, Tex. 75201	Quarry and plant--	Jackson.
Temple Eastex -----	Box 1270 West Memphis, Ark. 72301	Quarry -----	Comanche.
United States Gypsum Co --	101 South Wacker Dr. Chicago, Ill. 60606	Quarry and plant--	Blaine.
United States Steel Corp --	600 Grant St. Pittsburgh, Pa. 15230	Quarry -----	Do.
Lime:			
St. Clair Lime Co -----	Box 569 Sallisaw, Okla. 74955	Plant and quarry --	Sequoyah.
Natural gas and petroleum:³			
Pumice (volcanic ash):			
Axtell Mining Corp -----	Laverne, Okla. 73848	Open pit -----	Beaver.
Salt:			
Acme Salt Co -----	Box 420 Erick, Okla. 73645	Solar evaporation -	Harmon.
Blackmon Salt Co -----	Route 1 Freedom, Okla. 73842	----do -----	Woods.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Arkholo Sand & Gravel Co. ²	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	Pit and plant ----	McCurtain.
The Dolese Co. ² -----	13 Northwest 13th St. Oklahoma City, Okla. 73108	----do -----	Canadian, Garfield, Kingfisher, Logan, McClain.
E & A Materials, Inc -----	Box 365 Wichita Falls, Tex. 76307	----do -----	Cotton.
McMichael Concrete Co. ² --	Box 9486 Tulsa, Okla. 74107	----do -----	Tulsa.
Mohawk Rock and Sand Co.	Box 640 Sand Springs, Okla. 74063	----do -----	Do.
Pennsylvania Glass Sand Corp., Oklahoma Works.	Box 36 Mill Creek, Okla. 74856	----do -----	Johnston.
Shoffner Sand of Oklahoma, Inc.	Box 863 Edmond, Okla. 73084	----do -----	Oklahoma.
Stone:			
Anchor Stone Co. ⁴ -----	Box 1630 Tulsa, Okla. 74106	Quarry -----	Tulsa.
Eagle-Picher Industries, Inc.	Box 9 Cardin, Okla. 74335	Rock waste recovery	Ottawa.
Idabel Stone Co -----	Box 337 Idabel, Okla. 74745	Quarry -----	Choctaw and McCurtain.
Lattimore Industries, Inc --	Box 1186 Denison, Tex. 75020	----do -----	Bryan.
Leco Materials, Inc -----	Drawer D, Admiral Station Tulsa, Okla. 74115	----do -----	Nowata and Washington.
The Quapaw Co. ⁴ -----	Box 72 Drumright, Okla. 74030	----do -----	Creek.
Sooner Rock and Sand Co.--	Box 11195 Oklahoma City, Okla. 73111	----do -----	Murray.
Standard Industries, Inc --	Box 15670, Admiral Station Tulsa, Okla. 74115	----do -----	Kay, Osage, Tulsa.
Youngman, H. D., Contractor.	Box 647 Eufaula, Okla. 74432	----do -----	Choctaw, Haskell, Muskogee.
Tripoli:			
The Carborundum Co -----	Seneca, Mo. 64865 -----	Pits -----	Ottawa.
Midwestern Minerals Corp.	Box 831 Rogers, Ark. 72756	----do -----	Do.

¹ Also clays.² Also stone.³ Most of the major oil and gas companies and many smaller companies operate in Oklahoma and several commercial directories contain lists of them.⁴ Also sand and gravel.

The Mineral Industry of Oregon

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Department of Geology and Mineral Industries of Oregon, for collecting information on all minerals except fuels.

By J. M. West ¹

Oregon mineral production gained 6% in value over that of 1975, reaching \$112.6 million. The values of stone and sand and gravel output rose 6% and 13%, respectively. The value of minerals used for construction materials rose 9% and represented 89% of the total mineral production value.

Nickel amounting to 16,469 short tons in ores and concentrates was produced at the Hanna Mining Co. mine and smelter near Riddle, the only primary source of nickel in the United States. Teledyne Wah Chang Albany Corp. produced the Nation's only primary zirconium, utilizing imported ores. Titanium sponge production began again late in the year at the reequipped plant of Oregon Metallurgical Corp. (Oremet) in Albany. Two aluminum smelters on the Columbia River operated at full capacity. Increasing quantities of steel were produced at plants in the Rivergate district of Portland and at McMinnville. Small quantities of placer gold and precious and base metal ores were produced in northeastern and southwestern Oregon. Tungsten was produced at one property in northeastern Oregon.

Nonmetal production included cement from plants owned by one company in the Portland area and at Lime in eastern Oregon, and lime mostly from one company in the Rivergate area of Portland. Clay production rose 23% in quantity and 47% in value in 1976. Pumice, produced mainly near Bend, central Oregon, decreased in both value and quantity in

1976. Diatomite and talc were among other nonmetals produced. Gem stone collection remained extremely popular in Oregon, with crude gem stone values estimated at \$0.5 million.

Oregon traditionally has relied on hydroelectric power to supply the bulk of its industrial and home energy needs, but was increasingly turning to other energy sources to supplement steadily rising demands. Interest continued high in development of the State's geothermal resources, which have been utilized notably in the Klamath Falls area of southwest Oregon for many years. Drilling and plans for drilling test holes for thermal gradient and other data were reported in a number of favorable areas across the State. A plan was revealed to search for geothermal waters on the flanks of Mount Hood with the intent of supplying large quantities to the Portland area via pipeline. Investigations at one of the most favorable sites, Old Maid Flat, were delayed pending new Federal legislation which would open the area for exploration. The eastern Oregon cities of Vale and Ontario planned to develop hot water sources nearby for urban heating.

Oil and gas leasing activities remained high; favorable geologic structures were investigated mostly by geophysical studies with little drilling. Outer Continental Shelf investigations were limited to additional geophysical surveys. A liquefied

¹ State Liaison Officer, Bureau of Mines, Salem, Ore.

Table 1.—Mineral production in Oregon ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons--	120	\$214	147	\$815
Gem stones -----	NA	500	NA	525
Gold ----- troy ounces--	W	W	28	4
Lime ----- thousand short tons--	96	3,281	W	W
Nickel (content of ores and concentrates) ----- short tons--	16,987	W	16,469	W
Pumice ----- thousand short tons--	1,470	3,937	1,125	2,311
Sand and gravel ----- do-----	16,527	29,596	² 17,554	² 33,473
Stone ----- do-----	21,275	40,321	20,349	42,686
Value of items that cannot be disclosed:				
Cement, copper, diatomite, emery, lead, sand and gravel (industrial, 1976), silver (1975), soapstone, talc, tungsten concentrates, and values indicated by symbol W --	XX	28,155	XX	33,252
Total -----	XX	106,004	XX	112,566
Total 1967 constant dollars -----	XX	41,946	XX	P 40,467

^P Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Oregon, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Baker -----	\$8,629	\$10,587	Cement, stone, sand and gravel, clays, pumice, gold.
Benton -----	W	W	Stone, sand and gravel, clays.
Clackamas -----	W	W	Cement, sand and gravel, stone, clays.
Clatsop -----	W	1,446	Stone, sand and gravel.
Columbia -----	W	W	Sand and gravel, stone.
Coos -----	1,004	722	Stone, sand and gravel.
Crook -----	W	W	Stone, clays, sand and gravel.
Curry -----	252	99	Sand and gravel, stone.
Deschutes -----	1,634	1,978	Pumice, sand and gravel, stone.
Douglas -----	W	W	Nickel, sand and gravel, stone, pumice.
Gilliam -----	30	157	Stone.
Grant -----	W	W	Stone, sand and gravel.
Harney -----	611	363	Stone.
Hood River -----	W	379	Stone, sand and gravel.
Jackson -----	5,831	5,694	Do.
Jefferson -----	278	338	Do.
Josephine -----	W	644	Sand and gravel, stone, talc.
Klamath -----	W	W	Sand and gravel, stone, pumice, clays.
Lake -----	W	W	Stone, pumice, diatomite, sand and gravel.
Lane -----	6,721	7,762	Sand and gravel, stone.
Lincoln -----	1,328	1,529	Stone, sand and gravel.
Linn -----	W	1,985	Sand and gravel, stone.
Malheur -----	W	W	Lime, sand and gravel.
Marion -----	W	1,988	Sand and gravel, stone.
Morrow -----	W	W	Do.
Multnomah -----	W	10,692	Sand and gravel, lime, stone, clays.
Polk -----	662	476	Stone, sand and gravel.
Sherman -----	62	231	Stone.
Tillamook -----	614	541	Sand and gravel, stone.
Umatilla -----	1,338	1,119	Stone, sand and gravel.
Union -----	W	506	Sand and gravel, stone.
Wallowa -----	47	184	Do.
Wasco -----	831	45	Do.
Washington -----	5,063	W	Stone, sand and gravel, clays.
Wheeler -----	W	W	Sand and gravel.
Yamhill -----	W	W	Stone, sand and gravel, clays.
Undistributed ¹ -----	71,071	63,103	
Total ² -----	106,004	112,566	

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

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,040	1,070	+2.9
Unemployment ----- do-----	110	102	-7.3
Employment (nonagricultural):			
Mining ----- do-----	1.7	1.5	-11.8
Manufacturing ----- do-----	182.1	192.9	+5.9
Contract construction ----- do-----	35.3	36.2	+2.5
Transportation and public utilities ----- do-----	50.2	51.1	+1.8
Wholesale and retail trade ----- do-----	199.4	209.3	+5.0
Finance, insurance, real estate ----- do-----	48.9	51.5	+5.3
Services ----- do-----	142.7	149.5	+4.8
Government ----- do-----	177.1	180.3	+1.8
Total nonagricultural employment ----- do-----	837.4	872.3	+4.2
Personal income:			
Total ----- millions--	\$13,008	\$14,580	+12.1
Per capita ----- do-----	\$5,695	\$6,261	+9.9
Construction activity:			
Number of private and public residential units authorized-----	20,091	29,491	+46.8
Value of nonresidential construction----- millions--	\$244.8	\$210.9	-13.8
Value of State road contract awards ----- do-----	\$46.2	\$109.5	+137.0
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	775	795	+2.6
Mineral production value:			
Total crude mineral value ----- millions--	\$106.0	\$112.6	+6.2
Value per capita, resident population ----- do-----	\$46	\$48	+4.3
Value per square mile ----- do-----	\$1,093	\$1,161	+6.2

^p Preliminary.

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

natural gas storage terminal was under construction on the coast at Newport for balancing coastal gas supplies. Natural underground gas storage potential was investigated further in Columbia County, northwest Oregon. Construction began on a large coal-fired electricity-generating facility near Boardman in Morrow County to utilize Wyoming coal. Planned construction of nuclear generating facilities near Arlington, Gilliam County, was delayed by court action, although a trench was excavated at the site for geological investigations. The State's first nuclear powerplant operated intermittently as a peaking facility at Rainier on the lower Columbia River.

Plans of Alumax Pacific Corp. to build an aluminum reduction plant in the Um-atilla-Hermiston area of eastern Oregon were delayed by environmental studies and uncertainties about power availability. Additional exploration was conducted at a few copper and gold properties in north-eastern and southwestern Oregon. At two properties in Grant County, preparations were made for heap-leaching gold with cyanide solutions. Nickel exploration and sampling of laterites in southwestern Oregon were active, and metallurgical in-

vestigations by the Federal Bureau of Mines provided an improved extraction process for nickel and associated cobalt.

Several reports were published having special application for land-use planners. One described geology and mineral resources of Deschutes County, central Oregon, an area with geothermal potential and deposits of nonmetallic minerals, including diatomite, pumice, volcanic cinder and scoria, and gem stones.² A second report provided information on geologic hazards, engineering properties of landforms and geologic materials, and mineral resources in part of Curry County, southwestern Oregon.³ Potentials were discussed for construction materials, gold and silver, chromite, platinum, copper, nickel, and other mineral products.

A disposal site for hazardous materials was established 8 miles south of Arlington in Gilliam County by Chem-Nuclear Systems, Inc. The site, comprising 320 acres,

² Peterson, N. V., E. A. Groh, E. M. Taylor, and D. E. Stensland. Geology and Mineral Resources of Deschutes County, Oregon. Oregon Dept. Geol. and Miner. Ind. Bull. 89, 1976, 66 pp.

³ Beaulieu, J. D., and P. W. Hughes. Land-Use Geology of Western Curry County, Oregon. Oregon Dept. Geol. and Miner. Ind. Bull. 90, 1976, 148 pp.

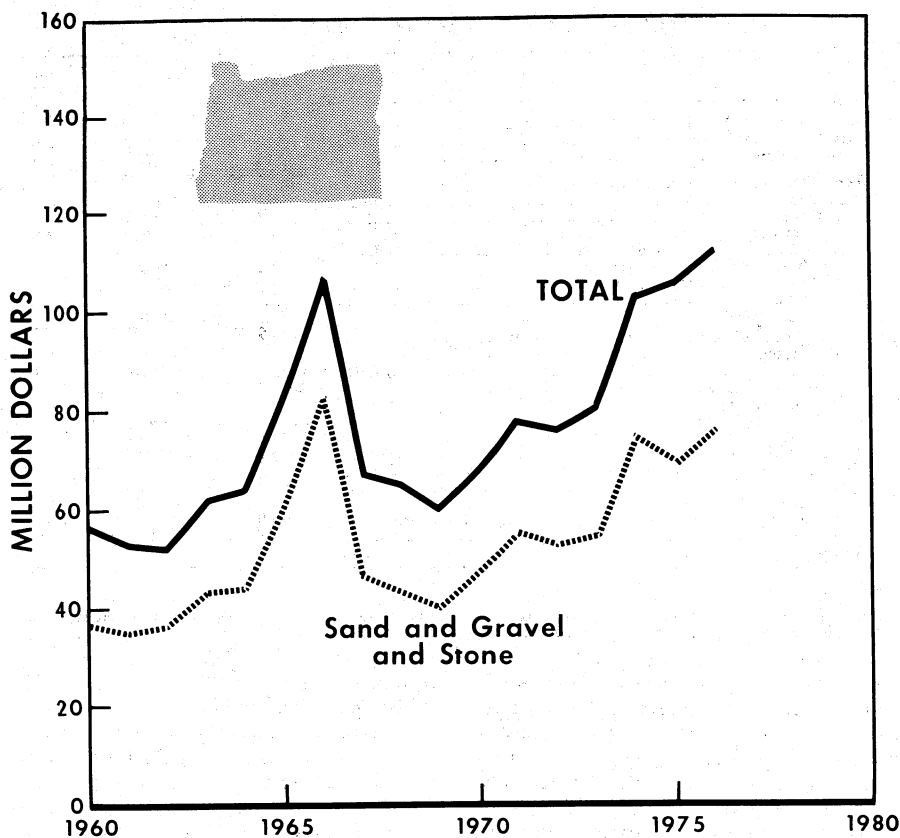


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Oregon.

was designed for toxic wastes such as caustic materials, insecticides, and various industrial wastes but excluded radioactive materials. Wastes were placed in asphalt-lined trenches 25 feet deep, 50 feet wide, and 500 feet long, which were monitored for leakage. Records were kept on stored wastes, and future recovery of useful components was considered a possibility.

Legislation and Government Programs.—The Oregon Department of Geology and Mineral Industries administered a program of mined-land reclamation, which included 31 projects in 1976. Reclamation of 30 to 40 acres of land per month was reported at costs averaging \$150 per acre. At yearend, 206 active sur-

face mining permits with approved reclamation plans were in effect. Total site registration, including properties partially exempt or not required to have permits, amounted to 1,314. New permits were issued at the rate of about five per month.

In a study that was part of the wilderness appraisal program conducted by the Federal Bureau of Mines and U.S. Geological Survey, a few metalliferous deposits were found in veins and near igneous contacts in the Eagle Cap Wilderness Area of the Willowa Mountains.⁴ The area studied

⁴ Weis, P. L., J. L., Gualtieri, W. F. Cannon, E. T. Tuckek, A. B. McMahan, and F. E. Federspiel. Mineral Resources of the Eagle Cap Wilderness and Adjacent Areas, Oregon. U.S. Geol. Surv. Bull. 1385-E, 1976, 100 pp.

covered parts of Baker, Union, and Wal-lowa Counties in northeastern Oregon. High-calcium limestones were considered a major nonmetallic resource of the area.

Other mineral studies were in progress on the Strawberry Mountain Wilderness Area, near John Day, central Oregon, and the Kalmiopsis Wilderness Area, west of Cave Junction, southwestern Oregon. A total of 950,000 acres of Oregon lands was under wilderness classification at the end of 1976, and an additional 380,000 acres was considered for withdrawal from mining or other uses in favor of wilderness purposes.

Statewide land-use planning in Oregon was expected to have an increasing impact on establishment and operation of mineral facilities. During 1976, the Land Conservation and Development Commission (LCDC), which was established by the State Legislature in 1973, prepared a re-

port intended as a base for planning and managing the coastal zone resources of Oregon.⁵ The program was the result of enactment by the Congress in 1972 of the Coastal Zone Management Act, affirming the national interest in effective management, beneficial use, protection, and development of the coastal zone. Oregon's program was to be submitted in 1977 to the Secretary of Commerce for review and approval according to provisions of the act.

During the program's preparation, detailed planning at county and local levels was underway to implement requirements as early as possible. The area affected by the program was defined generally as extending inland to the crest of the coastal mountain range and offshore through the Outer Continental Shelf. The land area to be managed was estimated at 7,811 square miles. Coastal resource inventories were in progress.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Sales by Oregon Portland Cement Co., the State's only producer, established new records with net sales increasing 28% in value to \$33 million and shipments 10% higher than in 1975.⁶ Cement and cement clinker were purchased to supplement production. The firm's Lake Oswego plant completed conversion of most of its operations to coal burning from natural gas and fuel oil. First-year savings of \$375,000 were expected, which was about half the cost of conversion. Coal received by train from the Kemmerer area of Wyoming was consumed at a rate of 250 tons per day. The company's other Oregon cement plant, located at Lime, eastern Oregon, operated at capacity in 1976 and also underwent conversion to coal. Two-thirds of the company's fuel needs were met by coal in 1976, and a 5-year supply contract was secured. An electrostatic precipitator was installed at the Lime plant, a half year ahead of State compliance requirements. Construction of a new 500,000-ton cement plant at Durkee, 12 miles northeast of the Lime plant, was planned, with a gradual phaseout of the latter.

Pumice.—The U.S. Pumice Co. applied to the Federal Bureau of Land Management (BLM) for patent on its 10 mining claims at Rock Mesa in the Three Sisters Wilderness Area. The application cleared the way for the U.S. Forest Service to file a recommendation with BLM for a mineral contest of the claims. The claims were the subject of dispute because of their wilderness location, and the Forest Service was considering an exchange for other land or outright purchase if claim rights were upheld. A \$75,000 study was begun by the Forest Service to appraise the claims and determine validity for use in subsequent negotiations. Mining at the site was delayed by the actions. Other pumice claims were under dispute at Newberry Crater, between East and West Paulina Lakes, Deschutes County.

Sand and Gravel.—Production was reported from all but three counties in 1976 and came principally from Clackamas, Multnomah, and Lane Counties. Output and value totaled 17.6 million tons and \$33.5 million, up 6% and 13%, corre-

⁵ Land Conservation and Development Commission. Oregon Coastal Management Program. 1976, 464 pp.

⁶ Oregon Portland Cement Co. Annual Report, 1976, 21 pp.

spondingly, from 1975 figures. In the coastal regions, sources of sand and gravel were increasingly limited, and most supplies for concrete aggregates were coming from Willamette Valley deposits.

A major producer, Ross Island Sand & Gravel Co., located on the Willamette River in the Portland area, maintained its dredge operations despite restrictions placed on the areas that local and State officials would allow the company to mine. For several years, the State made efforts to obtain title for the purpose of including the area in the Willamette River Greenway, a State project. An operating permit from the Oregon Division of State Lands prohibited the company from mining any areas of Ross Island above the high-water line before a long-range plan was approved. The company was forced to deeper excavation to continue production, and therefore requested permission to extend 30 feet below the 100 feet allowed in the existing permit. The State already had

contended that dredging to the edges of areas to be saved was causing banks to slough or become unstable. In late 1976, the R. B. Pamplin Corp. announced an agreement in principle to purchase Ross Island Sand & Gravel Co., and a management plan was proposed for deepening the dredge operation.

The dispute between the Corvallis Sand & Gravel Co. and the State of Oregon over ownership of meander sections of the Willamette River bed now abandoned by the river was sent to the U.S. Supreme Court, and a decision was due in January 1977. The company had mined the disputed area for about 50 years without a State lease, and the State sought to recover possession and collect damages for use of the sand and gravel. A State trial court had ruled in favor of State ownership for all but one parcel and awarded \$80,000 in damages to the State. However, in an appeal, the Oregon Supreme Court had ruled in favor of the company.

Table 4.—Oregon: Sand and gravel sold or used by producers in 1976¹

Use	Quantity (thousand short tons)	Value (thousands)	Unit value
PROCESSED			
Product:			
Sand	3,216	\$6,515	\$2.03
Gravel	11,238	23,770	2.12
Total processed ²	14,454	30,285	2.10
Uses:			
Commercial:			
Construction aggregate:			
Nonresidential and residential	2,914	6,056	2.08
Highway and bridge construction	369	711	1.93
Other uses (dams, waterworks, airports, etc.)	87	197	2.26
Concrete products (cement blocks, bricks, pipe, etc.)	373	764	2.05
Bituminous paving (asphalt and tar paving)	1,346	3,067	2.28
Roadbase and subbase	2,404	5,087	2.12
Fill	808	1,524	1.89
Other	319	621	1.95
Total commercial uses, processed sand and gravel ²	8,620	18,027	2.09
Government:			
Construction aggregate:			
Nonresidential and residential	112	181	1.61
Highway and bridge construction	924	1,717	1.86
Other uses (dams, waterworks, airports, etc.)	428	865	2.02
Concrete products (cement blocks, bricks, pipe, etc.)	101	312	3.09
Bituminous paving (asphalt and tar paving)	1,636	3,104	1.90
Roadbase and subbase	2,399	5,605	2.34
Fill	222	447	2.01
Other	12	27	2.25
Total Government uses, processed sand and gravel	5,834	12,258	2.10

See footnotes at end of table.

Table 4.—Oregon: Sand and gravel sold or used by producers in 1976¹—Continued

Use	Quantity (thousand short tons)	Value (thousands)	Unit value
UNPROCESSED			
Product: Sand and gravel, total -----	3,100	\$3,187	\$1.03
Uses:			
Commercial:			
Roadbase and subbase -----	937	942	1.01
Fill -----	948	1,159	1.22
Other -----	470	445	.95
Total commercial uses, unprocessed sand and gravel ³ -----	2,354	2,546	1.08
Government:			
Roadbase and subbase -----	474	452	.95
Fill -----	205	156	.76
Other -----	68	33	.49
Total Government uses, unprocessed sand and gravel ³ -----	746	641	.86
TOTALS			
Commercial sand and gravel sold or used ^{2,3} -----	10,974	20,574	1.87
Sand and gravel sold or used by Government agencies -----	6,580	12,899	1.96
All sand and gravel sold or used ² -----	17,554	33,473	1.91

¹ Comparable 1975 data not available because of change in method of compilation.

² Totals exclude small quantity of sand classified as industrial produced by one company.

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

Stone.—The quantity of stone decreased 4% from that reported for 1975, while value increased 6% during the same period. Stone came from an estimated 456 quarries throughout the State. Crushed stone was produced by 124 companies at 338 sites. Leading producers were the U.S. Forest Service, the Oregon Highway Department, and Oregon Portland Cement Co. Concern was expressed for preserving Yaquina Head, a scenic headland north of Newport on the Oregon Coast, where Yaquina Head Quarries, Inc., had produced riprap and crushed stone for many years. The quarry was one of the few

sources of stone on the coast, and any decision to terminate mining was expected to restrict stone supplies in the area. Public hearings were planned in 1977 to determine if the area would become a target for State action.

A 50% increase in limestone-processing capacity was scheduled for early 1977 at the Oswego plant of Oregon Portland Cement Co. Processing, largely for agricultural lime and cement manufacture, was expected to exceed 120,000 tons in 1976. The limestone was imported from British Columbia.

Table 5.—Oregon: Stone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone total -----	2	101	1	97
Crushed stone:				
Bituminous aggregate -----	1,414	2,979	1,166	2,742
Concrete aggregate -----	1,430	3,026	332	703
Dense-graded roadbase stone -----	4,216	7,320	4,314	8,405
Macadam aggregate -----	823	2,295	760	2,332
Surface treatment aggregate -----	4,532	10,056	7,185	15,372
Other construction aggregate and roadstone -----	3,311	6,608	3,113	6,344
Fill -----	28	34	41	47
Railroad ballast -----	455	931	222	423
Riprap and jetty stone -----	4,341	4,768	2,394	3,913
Other uses ¹ -----	723	1,702	820	2,309
Crushed stone total ² -----	21,273	40,220	20,348	42,589
Grand total -----	21,275	40,321	20,349	42,686

¹ Includes stone used in agricultural limestone, poultry grit and mineral food, filter stone, manufactured fine aggregate, cement and lime manufacture, ferrosilicon, glass manufacture, drain fields, and sugar refining.

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

METALS

Aluminum.—Oregon's two aluminum smelters produced at capacity throughout the year. Reynolds Metals Co. operated at Troutdale, and Martin-Marietta Aluminum, Inc., operated at The Dalles. Alumax Pacific Corp., which in 1975 selected the Hermiston area on the Columbia River for a \$380 million aluminum plant after environmental standards prevented construction at Warrenton, continued its interest in the Hermiston project. The firm however, began to look elsewhere for a plant site owing to delays from a Federal court decision requiring an environmental impact statement before the Bonneville Power Administration could contract to supply electricity. The Umatilla County Planning Commission granted a 1-year extension of a conditional use permit for the plant on April 7, 1976. Proposed plant capacity was 187,300 tons of aluminum per year.

Copper.—Texasgulf, Inc., explored the Iron Dyke copper mine, once a significant copper producer, located on the Snake River near Homestead, Baker County. Johns-Manville Corp. continued diamond drilling for copper at its Meadow Lake property on Elkhorn Ridge, north of Bourne, Baker County. Several companies explored for copper and related metals on the Rogue River, Douglas County, and in the Takilma area of southern Josephine County.

Gold and Silver.—Minor production came from small operations in northeast and southwest Oregon, mainly placers. Exploration and development were relatively active, however, and significant expenditures were made at several sites. At the Cougar and New York gold mines north of Granite, Grant County, W. A. Bowes & Associates drove underground development headings, using rubber-tired load-haul-dump equipment, and stockpiled ore. An asphalt pad was under construction near the Cougar mine for heap-leaching of gold and silver, scheduled to start in 1977. Dixie Meadows Gold Mines, Ltd., explored underground workings and opened a pit at its Dixie Meadows site, north of Prairie City, Grant County, in preparation for heap-leach testing. Small asphalt pads were constructed, and percolation tests were made on clayey pit material. Heap-leach tests were performed at the Virtue mine near Baker to determine applicability to mine dumps. Production by Basin Creek Mines, Inc., from a bench deposit above Basin Creek, northeast of Malheur Reservoir in Malheur County, was estimated at 1,000 ounces. Diamond drilling was conducted by Ibox Minerals, Inc., at the Bayhorse silver mine near Huntington on the Snake River. There were unconfirmed reports of many intermittent gold mining activities.

Iron and Steel.—Cascade Steel Rolling Mills, Inc., produced steel ingot at McMinnville from scrap automobiles, which were shredded at the plant site at rates of up to 600 per day. The plant contained two 8,000-kilovolt-ampere, 25-ton electric furnaces, a continuous-pour ingot casting unit, and a reinforcing bar plant. Operations were interrupted in August by a fire which destroyed a baghouse but were resumed in October. Facilities were added for producing steel fenceposts. At the plant of Oregon Steel Mills, owned by Gilmore Steel Corp., in Portland, a 25-ton slab was rolled into plate. The size rolled was said to be a record for mills west of the Rocky Mountains. The reduction plant utilized iron ore shipped as a slurry from British Columbia.

Magnesium.—Early in 1976, Oremet concluded its arrangement with Teledyne Wah Chang Albany Corp. whereby magnesium chloride salts from Teledyne's zirconium plant were processed and magnesium and chlorine returned to Teledyne for reuse. In May, Oremet obtained financing and began to refurbish its magnesium plant in preparation to resume production of titanium sponge, which also utilized magnesium in processing.

Nickel.—Hanna Mining Co. reported production at its mine and smelter near Riddle of 26.2 million pounds of nickel, with sales at 22.3 million pounds.⁷ Although a regional drought was expected to limit electric power supplies in 1977, effects on smelting were not considered likely to be significant because of alternate power sources. Completion of a fourth ore dryer was scheduled in 1977, increasing crude ore available for smelting. Hanna Mining, Inspiration Mining Co., and Inter-American Nickel Co. conducted studies of nickel-bearing laterites in Josephine and Curry Counties. The Bureau of Mines collected data on southern Oregon laterites and prepared for sampling in 1977 to supply material for metallurgical work at the Bureau's Albany Metallurgy Research Center.

Eight Dollar Mountain, Woodcock Mountain, and Red Flat were among the main areas of interest. An extraction proc-

ess developed at the Federal Bureau of Mines Albany Metallurgy Research Center employed a reduction roast with carbon monoxide at lower temperatures than are normally used in nickel processing, followed by leaching in a solution of ammonium hydroxide and ammonium sulfate, separating by solvent extraction, and electro-winning. Residues from the laterites, after extraction of nickel and cobalt, contained about 2% chromium, which it was believed might be commercially extractable by a combination of gravity, magnetic, and flotation methods. The Bureau of Mines scheduled research on the problem.

Titanium.—Oremet anticipated increased demand for titanium and obtained financing to refurbish and restart its titanium sponge-producing facilities. A \$3 million expenditure was planned, with completion in two stages—the first in January 1977 and the second in April 1977. Sponge production began in November 1976, ahead of schedule. The company was notified by the Oregon Department of Environmental Control that it had not complied with 1976 requirements limiting oil and grease in discharge waters to 2 parts per million (one-tenth of a previous requirement). Oremet produced titanium ingots and billets mainly from scrap in 1976. A unit believed to be the Western World's largest weld chamber for titanium castings was installed by TILine, Inc., in Albany. The chamber consisted of a revolving vacuum dome and an interior turntable, permitting parts to be positioned in any direction within the sealed space.

Uranium.—Several firms were active in uranium exploration in the central and south-central parts of the State. Western Nuclear Corp. drilled some holes at the White King mine in Lake County. Crook County was found to have some low-grade uranium mineralization.

Zirconium.—Teledyne Wah Chang Albany Corp. continued as the only U.S. manufacturer of zirconium, providing metal for nuclear reactors and other high-performance requirements. Control of plant wastes remained a severe problem.

⁷ The Hanna Mining Co., Annual Report, 1976, p. 8.

MINERAL FUELS

Coal.—Site preparation began in early 1976 on a \$500 million coal-burning electricity-generating plant 12 miles southwest of Boardman (Carty site). Owned by the Portland General Electric Co. (PGE), the plant was to burn an estimated 1.6 million tons of coal supplied by rail from eastern Wyoming, and was scheduled to produce at 500 megawatts capacity after completion in July 1980. Condenser cooling water was to be pumped from the Columbia River to a pond covering 2.2 square miles. A coal slurry pipeline was proposed as an alternative means of coal transport to the plant, through either Idaho or Montana.

Geothermal.—Most geothermal exploration in 1976 was east of the Cascade Range or in the Basin and Range provinces of southern and southeastern Oregon. Activity was less than in 1975 owing to delays in granting leases and discouragement from earlier drilling. Thermal Power Co. of San Francisco drilled to a depth of 5,840 feet at a site south of Klamath Falls but was forced to abandon the hole because it caved. The Eastern Oregon Community Development Council surveyed Baker and Union Counties for geothermal sources. Plans were made to utilize thermal waters found at Vale, Malheur County, for heating a greenhouse and other purposes.

The city of Klamath Falls applied for a \$4.8 million grant to finance a large geothermal heating system for downtown and residential areas and for a proposed college-industrial park complex. Several wells were to be drilled in the east-central part of the city where waters of about 200°F exist. Continuing drought in the Klamath Falls area was found to have affected recharge of geothermal water supplies, and local users were asked to reduce uncontrolled discharges of hot waste waters as a conservation measure.

The BLM held three lease sales during 1976, selling geothermal rights to 20,000 acres. Processing of environmental analysis records (EAR's) was accelerated by the Bureau. The EAR's contained environmental stipulations governing development in geothermal areas. By yearend, land in

Oregon under application or lease for geothermal rights was estimated at 2 million acres. An attempt was made to find sufficient hot water to heat the Timberline Lodge at Mount Hood, but after drilling 490 feet near the lodge, the drill stem stuck, and the project was abandoned. Another project, on the west flank of Mount Hood, was proposed for several geothermal test holes in the area of Old Maid Flat, located inside the Bull Run Reserve, from which Portland is supplied with drinking water. A U.S. district judge denied a petition to allow drilling on the basis of provisions in the Bull Run Trespas Act of 1904 and, in addition, closed the area to existing recreational activities. Studies were postponed until new Federal legislation could be enacted.

Northwest Natural Gas Co. reported a plan to develop geothermal sources on the flanks of Mount Hood and transport large quantities of hot water to the Portland area for industrial process water and steam and possibly domestic heating. A number of reports were issued during the year on geothermal studies.⁸

⁸ Batzle, M. L., S. E. Hammond, and K. R. Christopherson. Telluric Traverse Location Map and Profile for Breitenbush Known Geothermal Resource Area, Oregon. U.S. Geol. Survey Open-File Rept. 76-701D, 1976, 2 pp.

Bowen, R. G., D. D. Blackwell, D. A. Hull, and N. V. Peterson. Progress Report on Heat-Flow Study of the Brothers Fault Zone, Central Oregon. Ore Bin, v. 38, No. 3, 1976, pp. 39-46.

Hull, D. A. Electrical Resistivity Survey and Evaluation of the Glass Buttes Geothermal Anomaly, Lake County, Oregon. Ore. Dept. Geol. and Miner. Ind. Open-File Rept. 0-76-1, 1976, 11 pp.

Hull, D. A., R. G. Bowen, D. D. Blackwell, and N. V. Peterson. Geothermal Gradient Data, Brothers Fault Zone, Central Oregon. Ore. Dept. Geol. and Miner. Ind. Open-File Rept. 0-76-2, 1976, 24 pp.

Peterson, D. L., and R. F. Meyer. Principal Facts for a Gravity Survey of Summer Lake Known Geothermal Resource Area, Oregon. U.S. Geol. Survey Open-File Rept. 76-702A, 1976, 4 pp.

Sass, J. H., S. P. Galanis, Jr., R. J. Munroe, and I. C. Urban. Heat-Flow Data from South-eastern Oregon. U.S. Geol. Survey Open-File Rept. 76-217, 1976, 52 pp.

Senterfit, R. M., and G. M. Bedinger. Audio-Magnetotelluric Data Log and Station Location Map for the Klamath Falls Known Geothermal Resource Area. U.S. Geol. Survey Open-File Rept. 73-320, 1976, 6 pp.

Senterfit, R. M., and D. A. Dansereau. Station Location Map and Audio-Magnetotelluric Data Log for Summer Lake Known Geothermal Resource Area, Oregon. U.S. Geol. Survey Open-File Rept. 76-514, 1976, 6 pp.

Petroleum and Natural Gas.—Exploration mostly consisted of geophysical studies and geologic mapping. Leasing interest in Oregon remained high. Mobil Oil Co. held the largest area of leases, estimated to total 700,000 acres and located in Coos, Douglas, Lane, Linn, Benton, and Marion Counties. Late in the year, Mobil obtained leases from BLM to drill for oil and gas at 32 sites in 4 of these counties. Standard Oil of California and Texaco, Inc., were next in holdings, each with an estimated 200,000 acres in southwestern Crook and northwestern Harney Counties, eastern Oregon. Other companies and independents held or acquired leases in Coos, Douglas, Linn, Marion, Yamhill, Washington, Tillamook, and Columbia Counties, western Oregon, and Jefferson, Grant, Harney, and Malheur Counties, eastern Oregon.

The Oregon Department of Geology and Mineral Industries issued drilling permits in 1976 to Reichhold Energy Corp. and Michael T. Halbouty for deep holes in Columbia and Harney Counties, respectively. Geophysical permits for Outer Continental Shelf surveys were issued to five firms: Aero Service Co., BBN Geomarine Services Co., Shell Oil Co., Texaco, Inc., and Western Geophysical Co. BLM planned to call for leasing nominations to the shelf areas in 1977 in preparation for possible lease offerings in late 1978.

Reichhold Energy Corp. and Northwest Natural Gas Co. planned further exploration for natural gas and possibly to establish a natural underground site for gas storage in the upper Nehalem River Basin near Mist, Columbia County. The firms had joined in deep drilling for oil and gas in 1975 in Tillamook, Polk, Marion, and Columbia Counties without finding commercial quantities but were increasingly interested in the reservoir possibilities of deep formations in Columbia and Clatsop Counties. A report was issued by the State describing the geology and exploration history of the area under consideration for gas storage.⁹

Construction progressed on a \$13 million liquefied natural gas (LNG) plant at McLean Point, Newport, on the Oregon coast. The plant, owned by Northwest Natural Gas Co., was scheduled for com-

pletion in June 1977 and was supposed to receive LNG from the Kenai Peninsula in Alaska via tanker. However, owing to an unfavorable decision by the Federal Power Commission, the company found it was unable to obtain LNG from that source, although efforts to renegotiate contracts were continuing at yearend. A pipeline connecting the Newport plant with existing transmission and distribution lines was installed and tested in 1976. Until LNG became available, the plant was to draw on surplus gas from company pipelines to establish a reserve for winter peaking.

Cascade Energy, Inc., postponed its announced plans to begin construction by yearend on Oregon's first petroleum refinery, and instead conducted further feasibility studies. The project, to refine 30,000 barrels per day of petroleum imported from undisclosed sources, was expected to cost \$50 million and was to supply Oregon and Washington markets with gasoline and fuel oil to be distributed largely by barge on the Columbia River. The site was near Rainier, downstream from the Longview Bridge. Most necessary permits had been obtained, and construction was expected to require about 18 months to complete after initiation.

Nuclear.—Following a 5-month test period culminating in a full 1,100-megawatt test in May, the new Trojan nuclear powerplant of PGE near Rainier was shut down, owing partly to instrumentation and procedural problems. Several equipment malfunctions also occurred in early tests. The plant remained closed through the summer, but alternate power was available from hydroelectric facilities. The Oregon Energy Facility Siting Council filed a civil suit against the company for violating regulations on monitoring waste discharges and insisted that temperature and radioactivity measurements be performed more accurately. The firm was denied a request from the Oregon Department of Environmental Quality to relax pollution standards and was warned it would face fines up to \$10,000 per day if discharge standards were not met upon

⁹ Newton, V. C., Jr., and R. O. Van Atta. *Prospects for Natural Gas Production and Underground Storage of Pipeline Gas in the Upper Nehalem River Basin, Columbia-Clatsop Counties, Oregon.* *Oreg. Dept. Geol. and Miner. Ind. Oil and Gas Invest.* 5, 1976, 56 pp.

starting up again. Additional instruments were installed in an effort to meet requirements.

PGE's planned Pebble Springs nuclear powerplant at a site near Arlington on the Columbia River, consisting of two 1,260-megawatt units scheduled to go on-line in 1985 and 1988, was delayed by citizen challenges to site certification. Early in 1976, a 250,000-cubic-yard trench was excavated to obtain geologic information on the site. A State Court of Appeals ruling upheld a site certificate approved in 1975 by the State Nuclear and Thermal Energy Council, but an appeal filed in the Oregon Supreme Court later overthrew the ruling, leaving the question of certification undecided and subject to prolonged debate. The Supreme Court said the nuclear projects had not been judged against clear standards.

Other.—A \$3.8 million experimental plant to be operated by Bechtel Corp. for the Energy Research and Development Administration and to produce heavy bunker oil from wood chips or other agricultural waste products was scheduled for tests in

1977. The plant was built on the grounds of the Federal Bureau of Mines in Albany. About 30 barrels of oil was expected to be produced daily from 15 tons of wood chips.

Boeing Engineering and Construction Co., a division of Boeing Co., installed experimental heliostat units at Boardman, north-central Oregon, to collect solar energy. The units consisted of computer-controlled mirrors in plastic domes aimed at a common focal point where water was boiled to drive a generator.

Four major Oregon sites were identified by the U.S. Army Corps of Engineers as promising for pumped storage hydroelectric generation: Buster Creek, in the Nehalem River Basin; Eden Ridge, on the South Fork of the Coquille River south of Powers; Indian Rapids, near the Columbia River east of the John Day River; and Tumble Lake, on the North Santiam River, near the Detroit Reservoir. A number of lesser sites were also under consideration.

Pacific Fabricators, Inc., announced plans to establish a \$75 million facility at Warrenton, west of Astoria, to build offshore oil-drilling platforms.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
NONMETALS			
Abrasives:			
Lone Star Industries -----	Riddle, Ore. 97469 -----	Sandblasting abrasives from nickel slags.	Douglas.
Oregon Emery Co -----	1420 Lehigh Way Albany, Ore. 97321	Mine -----	Linn.
Cement: Oregon Portland Cement Co.	111 SE. Madison St. Portland, Ore. 97214	Cement, pozzolan, ground dolomite.	Baker and Clackamas.
Clays:			
Columbia Brick Works ----	1320 SE. Water St. Portland, Ore. 97214	Pit and plant ----	Multnomah.
Needy Brick and Tile Co --	Rt. 1, Box 133 Hubbard, Ore. 97032	----do -----	Clackamas and Marion.
Diatomite:			
A. M. Matlock -----	Box 3307 Eugene, Ore. 97402	Mine and plant ---	Lake.
American Fossil, Inc -----	Box 203 Christmas Valley, Ore. 97638	----do -----	Do.
Lime:			
Amalgamated Sugar Co -----	Nyssa, Ore. 97913 -----	Plant -----	Malheur.
Ash Grove Cement Co ----	1000 Tenmain Center Kansas City, Mo. 64105	----do -----	Multnomah.
Pacific Carbide & Alloys Co.	Box 17008 Portland, Ore. 97215	----do -----	Do.
Perlite: Supreme Perlite Co ---	Box 66 North Portland, Ore. 97043	----do -----	Do.
Pumice:			
Central Oregon Pumice Co.	5 Greenwood Ave. Bend, Ore. 97701	Mine and plant ---	Deschutes.
Cascade Pumice Co -----	Box 1087 Bend, Ore. 97701	----do -----	Do.
Sand and gravel:			
Ace Concrete Co -----	North 302 Park Rd. Spokane, Wash. 99200	Pit and plant ----	Jackson.
Joe Bernert Towing Co ---	Box 37 Wilsonville, Ore. 97070	Dredge and plant -	Clackamas.
J. R. Chapin -----	411 Salmon North Salem, Ore. 97303	Pit and plant ----	Marion.
J. C. Compton Co -----	Box 86 McMinnville, Ore. 97123	----do -----	Douglas.
Delta Sand and Gravel Co.--	999 Division Ave. Eugene, Ore. 97401	----do -----	Lane.
Eugene Sand and Gravel Co.	700 East 8th Ave. Eugene, Ore. 97401	----do -----	Do.
Glacier Sand and Gravel Co.	3510 SW. Bond Ave. Portland, Ore. 97201	----do -----	Columbia.
Ross Island Sand & Gravel Co.	4129 SE. McLoughlin Blvd. Portland, Ore. 97202	Pit -----	Multnomah.
Umpqua River Navigation Co.	Box 25 Reedsport, Ore. 97467	Dredge and plant..	Douglas.
Wildish Sand and Gravel --	Box 1106 Eugene, Ore. 97401	Pit -----	Lane.
Willamette Western Corp --	Foot of North Portsmouth Ave. Portland, Ore. 97203	Dredge and plant..	Multnomah.
Silica: Bristol Silica Co -----	Box 400 Rogue River, Ore. 97537	----do -----	Jackson.
Stone:			
L. V. Anderson Construction Co.	Box 757 Oakridge, Ore. 97463	Quarries and plants	Various.
L. H. Cobb -----	8275 SW. 145th Ave. Beaverton, Ore. 97005	Quarry and plant..	Washington.
McCall Crushing, Inc ----	1075 Wilco Rd. Stayton, Ore. 97383	Quarry -----	Morrow.
F. H. McEwen Construction Co.	Rt. 1, Box 382 Shedd, Ore. 97377	----do -----	Linn.
C. C. Meisel Co -----	Box 206 McMinnville, Ore. 97123	Quarry and plant..	Yamhill.
Oregon Portland Cement Co.	111 SE. Madison Portland, Ore. 97214	----do -----	Baker.
S. D. Spencer and Sons ---	4614 NE. 72d Ave. Vancouver, Wash. 98661	Quarry -----	Douglas.
Springfield Quarry Rock Products, Inc.	702 South 28th St. Springfield, Ore. 97477	Quarry and plant..	Lane.
Talc and soapstone:			
John H. Fugh -----	2891 Elk Lane Grants Pass, Ore. 97526	Mine -----	Josephine.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Vermiculite:			
Supreme Perlite Co -----	Box 66 North Portland, Oreg. 97643	Plant -----	Josephine.
Vermiculite-Northwest, Inc.	Box A Auburn, Wash. 98002	----do -----	Do.
METALS			
Ferrous:			
Steel mills:			
Cascade Steel Rolling Mills, Inc.	3200 North Hwy. 99W McMinnville, Oreg. 97128	Mild steel products, rebars.	Yamhill.
Oregon Steel Mills ----	14400 North Rivergate Blvd. Portland, Oreg. 97208	Iron ore pellets, carbon steel plates.	Multnomah.
Iron and steel foundries:			
Columbia Steel Casting Co., Inc.	10425 North Bloss Portland, Oreg. 97203	Mining and crushing equipment castings.	Do.
Esco Corp -----	2141 NW. 25th Portland, Oreg. 97210	Construction equipment castings.	Do.
Pacific Chain Manufacturing Co.	4200 Yeon Ave. Portland, Oreg. 97210	Steel castings ----	Do.
Precision Castparts Corp.	4600 SE. Harney Dr. Portland, Oreg. 97206	Investment castings	Do.
Rich Manufacturing Co. of Oregon.	866 North Columbia Blvd. Portland, Oreg. 97217	Gray iron castings--	Do.
Western Foundry Co --	8200 SW. Hunzicker Rd. Tigard, Oreg. 97223	Iron castings ----	Do.
Electrometallurgical products:			
Hanna Mining Co ----	Box 85 Riddle, Oreg. 97469	Ferronickel -----	Douglas.
Union Carbide Corp ---	11920 North Burgard Rd. Portland, Oreg. 97203	Ferromanganese, silicomanganese.	Multnomah.
Nonferrous:			
Base and precious metals mining:			
Basin Creek Mines, Inc.	Brogan, Oreg. 97903 -----	Gold placer -----	Malheur.
Snowbird Mining Co --	243 Fields Rd. Williams, Oreg. 97544	Lode mine, copper-	Josephine.
Taylor & Whitney ----	Sumpter, Oreg. 97877 -----	Lode mine, gold, copper.	Baker.
Smelting and refining:			
Aluminum:			
Martin Marietta Aluminum, Inc.	3313 West 2d St. The Dalles, Oreg. 97058	Aluminum ingots -	Wasco.
Reynolds Metals Co.	Sun Dial Rd. Troutdale, Oreg. 97060	----do -----	Multnomah.
Other:			
National Metallurgical Corp.	1801 South A St. Springfield, Oreg. 97477	Silicon metal alloy.	Lane.
Oregon Metallurgical Corp.	Box 580 Albany, Oreg. 97321	Titanium ingots, zirconium castings, magnesium ingots.	Linn.
Teledyne Wah Chang Albany Corp.	1600 Old Pacific Hwy. Albany, Oreg. 97321	Zirconium, hafnium, columbium, ingots and castings.	Do.
Foundries and rolling:			
Future Products Co ---	3625 North Mississippi Ave. Portland, Oreg. 97227	Die castings -----	Multnomah.
Oregon Brass Works --	1127 SE. 10th Ave. Portland, Oreg. 97214	Brass and aluminum castings.	Do.
Rem Metals Corp -----	Box 829 Albany, Oreg. 97321	Precision castings -	Linn.
TILine, Inc -----	Box 729 Albany, Oreg. 97321	Titanium and zirconium castings.	Do.
West Coast Alloys Co.--	2345 NE. 244th Troutdale, Oreg. 97060	Abrasion-resistant castings.	Multnomah.
Zirtech, a div. of Kawecky Berylco, Inc.	3615 SW. Pacific Blvd. Albany, Oreg. 97321	Titanium and zirconium castings, rolled products.	Linn.

The Mineral Industry of Pennsylvania

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, under a cooperative agreement for collecting information covering mineral production from mines, quarries, and wells.

By William Kebblish ¹

Pennsylvania mineral production value reached a record \$3,041 million, a \$133.3 million increase above that of 1975, but \$57.3 million less, based on 1967 constant dollars. Compared with 1975, increases in value were attained by masonry and portland cement, anthracite coal, bituminous coal, lime, natural gas, sand and gravel, stone, and zinc. The decrease in petroleum value was due to a slight decrease in production. Collectively, solid fuels production accounted for slightly more than 78% of the total mineral production value, and the value of all fossil fuels equaled 81.7% of the total mineral production value.

Leading producing counties, with primary commodities in parentheses, were Washington, Indiana, Clearfield, and Greene Counties (bituminous coal); Schuylkill, Luzerne, and Northumberland (anthracite coal); Centre (lime); and Montgomery, Lancaster, Bucks, Northampton, and Chester (stone). Pennsylvania led the Nation in production of stone, anthracite coal, and pig iron; third in production of bituminous coal; fourth in smelter production of cadmium; and eighth in the production of zinc.

¹ State Liaison Officer, Bureau of Mines, Harrisburg, Pa.

Table 1.—Mineral production in Pennsylvania ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ----- thousand short tons--	357	\$14,640	379	\$16,903
Portland ----- do-----	5,815	168,220	5,989	185,170
Clays ² ----- do-----	1,945	13,672	2,291	16,037
Coal:				
Anthracite ----- do-----	6,203	198,481	6,228	209,234
Bituminous ----- do-----	84,137	2,111,009	85,777	2,178,009
Gem stones -----	NA	9	NA	9
Lime ----- thousand short tons--	1,940	60,047	2,069	68,356
Natural gas ----- million cubic feet--	84,676	57,156	89,336	61,229
Peat ----- thousand short tons--	27	488	W	W
Petroleum (crude) ----- thousand 42-gallon barrels--	3,264	39,647	3,019	36,700
Sand and gravel ----- thousand short tons--	17,401	48,742	19,038	55,611
Stone ----- do-----	60,177	149,670	63,607	165,889
Zinc (recoverable content of ores, etc.) ----- short tons--	21,090	16,450	22,280	16,487
Value of items that cannot be disclosed:				
Clays (kaolin), copper (1976), iron ore, mica (scrap), natural gas liquids, tripoli, and values indicated by symbol				
W -----	XX	29,607	XX	36,553
Total -----	XX	2,907,838	XX	3,041,187
Total 1967 constant dollars -----	XX	1,150,632	XX	^p 1,093,306

^p Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes kaolin; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Pennsylvania, by county^{1,2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams	W	W	Stone, lime, clays, mica.
Allegheny	\$124,766	\$134,474	Coal, cement, petroleum, stone, clays, sand and gravel.
Armstrong	W	W	Coal, sand and gravel, stone, clays, petroleum.
Beaver	W	W	Coal, sand and gravel, clays, petroleum.
Bedford	W	W	Coal, stone, sand and gravel.
Berks	49,935	59,430	Iron ore, cement, stone, coal, sand and gravel, clays, copper.
Blair	3,364	W	Stone, sand and gravel, coal.
Bradford	W	W	Sand and gravel.
Bucks	W	W	Stone, sand and gravel, clays.
Butler	50,648	57,039	Coal, lime, cement, stone, petroleum, sand and gravel, clays.
Cambria	267,816	284,363	Coal.
Cameron	—	W	Sand and gravel.
Carbon	W	W	Coal, sand and gravel, stone.
Centre	W	W	Coal, lime, stone, clays.
Chester	W	W	Stone, lime, clays.
Clarion	92,308	W	Coal, stone, petroleum.
Clearfield	173,237	181,484	Coal, clays, stone.
Clinton	W	W	Coal, stone, clays.
Columbia	W	W	Coal, sand and gravel, stone.
Crawford	W	W	Sand and gravel, petroleum.
Cumberland	W	W	Stone, sand and gravel, clays.
Dauphin	W	W	Stone, coal, sand and gravel.
Delaware	W	W	Stone.
Elk	W	W	Coal, petroleum, stone.
Erie	2,970	W	Sand and gravel, peat, petroleum.
Fayette	W	67,959	Coal, stone, clays, petroleum.
Forest	W	W	Petroleum, sand and gravel, stone.
Franklin	W	W	Stone, sand and gravel.
Fulton	W	W	Stone, sand and gravel, coal.
Greene	W	W	Coal, petroleum.
Huntingdon	9,093	8,902	Sand and gravel, stone, clays, coal.
Indiana	198,168	W	Coal, stone, petroleum.
Jefferson	44,433	48,996	Coal, clays, stone, petroleum.
Junata	312	193	Stone.
Lackawanna	W	10,869	Coal, peat, stone, sand and gravel.
Lancaster	W	W	Stone, sand and gravel, clays.
Lawrence	W	W	Cement, coal, stone, sand and gravel, clays, peat.
Lebanon	W	W	Lime, stone.
Lehigh	W	W	Cement, zinc, stone.
Luzerne	W	W	Coal, stone, sand and gravel, peat, clays.
Lycoming	8,380	10,269	Coal, stone, sand and gravel.
McKean	W	W	Petroleum, clays, stone.
Mercer	8,239	W	Coal, sand and gravel, stone, petroleum.
Mifflin	W	W	Stone, sand and gravel, lime.
Monroe	W	W	Stone, sand and gravel, clays, peat.
Montgomery	W	W	Stone, lime, cement, clays.
Montour	W	W	Stone.
Northampton	82,750	W	Cement, stone, sand and gravel.
Northumberland	W	W	Coal, stone, sand and gravel, clays, tripoli.
Perry	W	W	Stone.
Pike	W	W	Sand and gravel, stone.
Potter	W	W	Petroleum, stone.
Schuylkill	W	105,872	Coal, stone, sand and gravel.
Snyder	W	W	Stone, coal.
Somerset	W	W	Coal, stone, clays, sand and gravel.
Sullivan	551	1,560	Coal.
Susquehanna	472	W	Stone, coal.
Tioga	W	W	Coal, sand and gravel, stone.
Union	W	W	Stone, clays.
Venango	15,854	23,133	Coal, petroleum, sand and gravel, natural gas liquids.
Warren	7,346	6,758	Petroleum, sand and gravel, natural gas liquids.
Washington	W	W	Coal, petroleum, clays.
Wayne	W	W	Stone, sand and gravel.
Westmoreland	81,298	W	Coal, stone, sand and gravel.
Wyoming	1,775	W	Sand and gravel.
York	34,043	43,327	Cement, stone, lime, sand and gravel, clays.
Undistributed ³	1,650,077	1,996,560	
Total ⁴	2,907,838	3,041,187	

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

¹ Philadelphia County is not listed because no production was reported.

² Value of petroleum is based on an average price per barrel for the State.

³ Includes some natural gas liquids that cannot be assigned to specific counties, natural gas, petroleum, gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of Pennsylvania business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	5,072	5,120	+0.9
Unemployment ----- do-----	422.0	406.2	-3.8
Employment (nonagricultural):			
Mining ----- do-----	46.1	48.0	+4.1
Manufacturing ----- do-----	1,334.8	1,332.3	-2
Contract construction ----- do-----	184.5	180.6	-2.1
Transportation and public utilities ----- do-----	256.5	255.0	-6
Wholesale and retail trade ----- do-----	886.8	914.9	+3.2
Finance, insurance, real estate ----- do-----	207.3	210.5	+1.5
Services ----- do-----	798.5	831.7	+4.2
Government ----- do-----	721.4	718.8	-4
Total nonagricultural employment ----- do-----	¹ 4,435.7	¹ 4,491.7	+1.3
Personal income:			
Total ----- millions--	\$69,642	\$76,385	+9.7
Per capita ----- do-----	\$5,872	\$6,439	+9.7
Construction activity:			
Number of private and public residential units authorized -----	33,019	42,111	+27.5
Value of nonresidential construction ----- millions--	\$447.9	\$564.4	+26.0
Value of State road contract awards ----- do-----	\$199	\$150	-24.6
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	2,920	3,024	+3.6
Mineral production value:			
Total crude mineral value ----- millions--	\$2,907.8	\$3,041.2	+4.6
Value per capita, resident population ----- do-----	\$245	\$256	+4.5
Value per square mile ----- do-----	\$64,144	\$67,085	+4.6

^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.

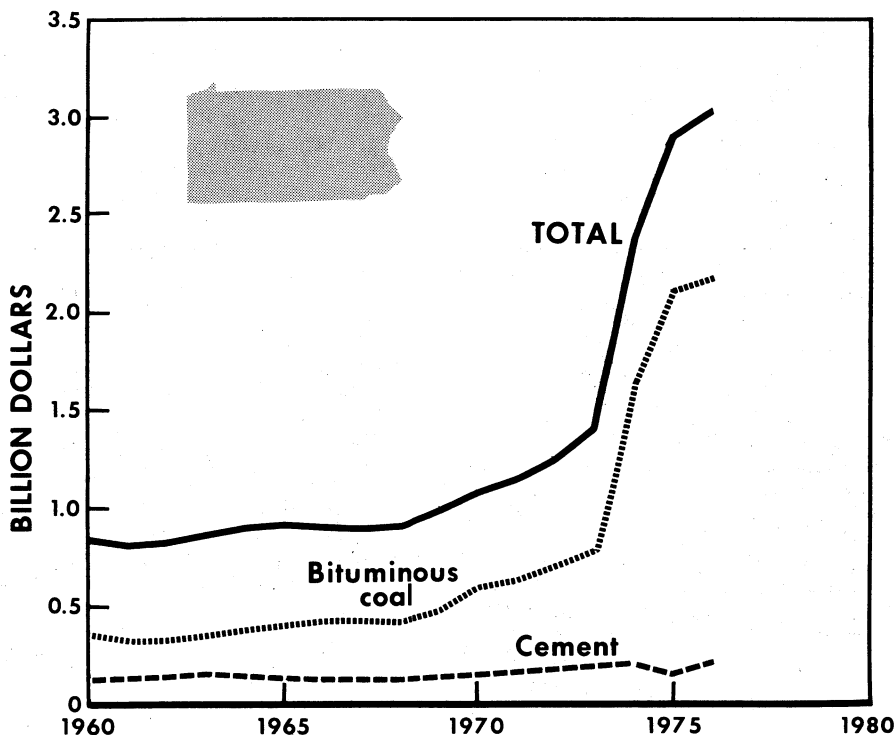


Figure 1.—Value of bituminous coal, cement, and total value of mineral production in Pennsylvania.

Legislation and Government Programs.

—Legislation enacted during the year of interest to the minerals industries included the following:

Act 145, amended the act of March 31, 1937 (P.L. 160, No. 43), entitled "An Act creating a commission to be known as the Pennsylvania Public Utility Commission (PUC)," on July 9, 1976 by adding Section 7.1: which pertains to establishing a Bureau of Conservation, Economics and Energy Planning.

Acts 103 and 120, which amended The Land and Water Conservation Act (Act 443 of 1968) known by several short titles with respect to the abandoned mine reclamation portion: "Project 500," "Operation Scarlift," or "The Bond Issue Program." There have been several amendments to the basic act affecting Section 16a that covered abandoned mine reclamation work. Two such amendments, Nos. 103 and 120,

were passed in 1976. Currently, this act authorizes the expenditure of \$200 million to June 30, 1981, for abandoned mine reclamation as follows: \$140 million for the abatement of acid mine drainage (AMD); \$20 million for the abatement of air pollution from burning refuse banks; and \$40 million for the control of underground mine fires, and the control of surface subsidence over abandoned mines.

As of December 31, 1976, the following net expenditures and encumbrances, along with accomplishments, have been made since inception of the program:

AMD Abatement: 344 projects, \$72.6 million;

200 miles of streams improved, 10 treatment plants in operation, 32 deep mine complexes sealed, 2,500 acres restored, and 37 banks reclaimed.

Burning Banks: 20 projects, \$17.0 million;

9 million cubic yards of material handled.

Underground Fires and Subsidence: 122 projects, \$28.4 million; 1,164 acres of built-up areas protected representing \$311 million of real estate.

In addition to the State funds, about \$23 million in matching Federal funds have been used.

Act 264, defines emergency medical technician; authorizes such personnel to render emergency care; exempts such personnel and physicians working in conjunction with them from civil liability when rendering such care; and makes repeals.

The Emergency Medical Training Program, Act 178, signed into law July 9, 1976, with an effective date 60 days after date of enactment provides the following: At least one emergency medical technician (EMT) shall be on duty at a mine at any time when miners at that mine are engaged in the extraction, production, or preparation of coal. EMTs shall be on duty at a mine in sufficient numbers to assure that no miner shall work in a mine location that cannot be reached within a reasonable time by an EMT. EMTs shall be employed on their regular mining duties at locations convenient for quick response to emergencies, and further shall have available to them necessary equipment at all times in compliance with Federal regulations.

On or before July 1, 1978, operators of coal mines shall make adequate provisions so that at least one EMT paramedic, registered nurse, physician, or physician's assistant shall be available to provide care at a mine at any time that miners at the mine are engaged in the extraction, production, or preparation of coal, and such EMT paramedic, registered nurse, physician, or physician's assistant shall be on call to reach the entrance of the mine within 30 minutes.

The law also provides regulations for training and certification, first aid training of coal mine employees, continuing liability of physicians and surgeons, and equivalent training.

Act 180, amending the Act of June 2, 1915 (P.L. 736, No. 338), entitled, as amended, "An Act defining the liability of an employer to pay damages for injuries received by an employee in the course of employment; establishing an elective schedule of compensation; and providing proce-

dures for the determination of liability and compensation thereunder; and prescribing penalties," further defining occupational disease to include fractionation area employees who develop hepatitis.

Act 222, amending the Act of June 22, 1937 (P.L. 1987, No. 394), entitled, as amended, "An act to preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for industrial consumption, and recreation; empowering and directing the creation of indebtedness or the issuing of nondebt revenue bonds by political subdivisions to provide works to abate pollution, providing protection of water supply; providing for the jurisdiction of courts in the enforcement thereof; providing additional remedies for abating pollution of waters; imposing certain penalties; repealing certain acts; regulating discharges of sewage and industrial wastes; regulating the operation of mines; and placing responsibilities upon landowners and land occupiers," changing provisions relating to penalties.

Act 279, amending the Act of January 8, 1960 (1959 P.L. 2119, No. 787), entitled, as amended, "An Act to provide for the better protection of the health, general welfare, and property of the people of the Commonwealth by the control, abatement, reduction and prevention of the pollution of the air by smokes, dusts, fumes, gases, odors, mists, vapors, pollens and similar matter, or any combination thereof; imposing certain powers and duties on the Department of Environmental Resources (DER), the Environmental Quality Board, and the Environmental Hearing Board; establishing procedures for the protection of health and public safety during emergency conditions; creating a stationary air contamination source permit system; providing additional remedies for abating air pollution; reserving powers to local political subdivisions and defining the relationship between this act and the ordinances, resolutions, and regulations of counties, cities, boroughs, towns, and townships; imposing penalties for violation of this act; and providing for the power to enjoin violations of this act; and conferring upon persons aggrieved certain rights and remedies," exempting the production of agricultural commodities in their unmanufactured state from the provisions of the act.

The Environmental Quality Board adopted policies for critical environmental areas for the Commonwealth's Environmental Master Plan on November 18, 1976. The policies are not, nor are they intended to be, rules or regulations, nor the sole determinants for guiding future Commonwealth actions. The development of policies that reflect an overall environmental sensitivity may be, in some instances, in conflict with other policies addressing social and economic priorities. The resolution of policy conflict and the resultant balancing of priorities and social costs is recognized as an integral part of any program to implement the master plan. The policies of the Environmental Master Plan begin to provide the foundation for environmentally sensitive growth and development throughout Pennsylvania. The policies provide an ecologically sound perspective to plan for future growth and also identify environmental concerns that must be studied and considered in the decisionmaking process.²

The Commonwealth of Pennsylvania was granted \$292,000 by the National Oceanic and Atmospheric Administration (NOAA) to continue work on Pennsylvania's Coastal Zone Management Program. The grant will be used to build a program of balanced prudent use of the State's two coastal areas—the Lake Erie coast and the tidal estuary in the Lower Delaware River. This is the third grant made by the Federal Government to Pennsylvania coastal zone management.

Pennsylvania mines release more than 50 million cubic feet of methane daily during mining operations and efforts are being made to recover this previously wasted fuel, which is currently being ventilated to the atmosphere. Two years ago Pennsylvania State University with joint funding by the Pennsylvania Science and Engineering Foundation and the Federal Bureau of Mines established a research group to advance the technology of methane recovery. Three wells were drilled on the Cumberland mine site approximately 7 miles south of Waynesburg. Drilling was initiated in November 1975 on Well No. 1034, which was drilled to a depth of 825 feet and located to intersect one of the main entries of the underground coal mine. Drill Hole No. 1036, which was drilled to a depth of 1,025 feet into the Pittsburgh seam, was used as a control or reference hole since it is located in an area that will permit

up to 5 years of undisturbed observation and monitoring. The third well, No. 1035, was planned to intersect the Freeport seam at a depth of 1,300 feet. Natural methane flow from the three wells is being observed prior to stimulation, which will occur at a later date.³

The Federal Bureau of Mines is attempting to use coalbed degasification methods at a mine being developed by Emerald Mine Corp. in Greene County. Scientists estimate that at least 245 million cubic feet of methane is trapped in the part of the Pittsburgh coal seam underlying the 129-acre test site.⁴

The U.S. Army Corps of Engineers will handle construction of an aboveground complex for testing underground mining machinery under a \$12 million interagency agreement with the Interior Department's Bureau of Mines. The Corps will contract for construction of the complex, furnishing construction management expertise. The "proving grounds," to be built at the Bureau's Pittsburgh Mining and Safety Research Center in Bruceton, will feature areas for equipment trials, roof support research, and research and development on hydraulic transportation of coal. A laboratory and test plant for coal-cleaning research is proposed as a later addition. Elements of the complex was scheduled to be ready for use by the Bureau in the fall of 1977.⁵

A contract for operating the newly constructed Synthane Pilot Plant, near Pittsburgh, was signed recently by ERDA and C-E Lummus Company. ERDA will provide \$26.3 million for operation of the plant between August 1976 and September 1978. C-E Lummus, a subsidiary of Combustion Engineering, Inc., will operate the plant under a cost-plus-fixed-fee contract. The pilot plant will use coal for conversion to synthetic gas. This plant is the only high-Btu gasification facility in the United States wholly supported with Federal funds. The \$15 million Synthane plant, located in South Park Township, Allegheny County, is designed to process 72 tons of coal per day into 1.2 million cubic feet of pipeline-quality gas.

² Pennsylvania Bulletin. V. 7, No. 4, Jan. 22, 1977.

³ Earth and Mineral Sciences. V. 46, No. 3, December 1976.

⁴ U.S. Department of the Interior. News Release, Nov. 10, 1976.

⁵ U.S. Department of the Interior. News Release, July 26, 1976.

Admiral Peary, Vocational-Technical School located in Ebensburg, Cambria County, received \$45,500 from the Appalachian Regional Commission as a grant to aid in construction and \$81,260 from the U.S. Office of Education for a curriculum to train students for the coal mining industry and to retrain current mining employees.

Waynesburg College approved a unique baccalaureate degree mine-management-major program designed for students who have completed 2-year mining technology programs. The new major, which covers the junior and senior years, was developed following a recommendation to the college's Mining Advisory Committee of Industry and Union representatives. The college faculty recently approved the mine management major as part of Waynesburg's regular academic program.

Environment.—Control of air pollution in Pennsylvania, especially in the Pittsburgh region, continued to be a problem throughout the year. The Group Against Smog and Pollution (GASP) questioned reliability of air pollution data and sampling methods used to monitor the air during a recent pollution emergency. GASP also requested assistance from the Common Pleas Court concerning pollution controls from the steel industries' coke ovens. It was reported that the Occupational Safety and Health Administration (OSHA) requested Wheeling-Pittsburgh Steel Corp. to comply with OSHA regulations on coke oven coal tar pitch volatiles. United States Steel Corp. was cited by State and Allegheny County agencies with 241 violations of a 1972 consent decree to curb air pollution at U.S. Steel's Clairton Coke Works. President Judge Ellenbogen of Common Pleas Court ordered attorneys for both sides to consider the new consent decree and begin to implement the pact, which permits U.S. Steel 7 years to achieve substantial compliance with new standards and until 1988 to reach full and final compliance. U.S. Steel plans to spend more than \$600 million at the Clairton facility to construct 3 new coke oven batteries, to rehabilitate 7 others, and shut down 13 older batteries.

Bethlehem Steel Co. was cited by Pennsylvania officials of polluting the air in Johnstown with Benzo (A) Pyrene (BAP) that are 30 to 60 times higher than the national average. Coke ovens and a cinder plant were cited as the major pollutant

sources. In late August, Bethlehem Steel and the DER reached a tentative agreement on pollution control measures, but in early December a lawsuit by the State charged Bethlehem with coke oven pollution violations.

A plan for fighting a mine fire threatening Fayette County homes was approved by the Secretary of the Interior. The Department of the Interior said its Bureau of Mines and Pennsylvania DER jointly investigated leaks of sulfur dioxide and carbon monoxide in parts of Upper Tyrone and Bullsken Townships. The source of the leaks was verified as an underground fire in an abandoned coal mine. To protect residents, the plan calls for sealing holes funneling carbon monoxide and sulfur dioxide toward homes. To shut off the fire's air supply, surface cracks will be sealed by plowing and compacting the earth.

Allegheny Power System Inc. will conduct research on a method of removing sulfur dioxide from stack gases at its coal-burning generating plant near Pittsburgh. If successful, the \$7 million project conducted over a 2- to 3-year period would be applied to the entire plant at a total cost of \$45 million.

Residents of the once-thriving coal-mining city of Shamokin in central Pennsylvania can look forward to possible relief from acrid fumes, smoke, and land slippage that have plagued them for more than 25 years. A mine fire, detected as long ago as 1951, has since spread through six coalbeds of the abandoned Cameron Colliery mine, which was in operation from about 1866 to the mid-1930's. The waste bank consists of about 14 million cubic yards of refuse from the mine. Burning portions of it contain 4 to 5 million cubic yards of material, extending nearly a mile along Big Mountain and rising 200 to 400 feet higher than the city. Pollution from the fire has posed serious health hazards to Shamokin residents, particularly the elderly and those with respiratory problems, and especially on windless days when stagnant air is locked against the mountain. The Bureau of Mines estimates that completion of the entire project would take about 3 years.⁶

A grant of \$225,000 was made by the Appalachian Regional Commission to halt a mine fire that has been burning at Wan-

⁶ U.S. Department of the Interior. News Release, Sept. 27, 1976.

amic Colliery 19, Newport Township, since 1959. In addition, the State will add \$75,000 to meet the \$300,000 cost of the project. State Department of Environmental Resources, Bureau of Appalachian Development, has reported that the fire is spreading and now is within 100 feet of the barrier pillar between No. 19 mine and the Susquehanna No. 6 mine. Under the grant, an ash barrier will be placed in a trench between the fire and the barrier pillar.

Costly pollution control devices will be eliminated if the \$35 million coal cleaning plant of Pennsylvania Electric Co. (Penelec) fulfills expectations in Indiana County. The plant, scheduled to open in 1977, is being constructed near a Penelec coal mine and near a 650,000-kilowatt generating station that Penelec is building in Homer City at a cost of more than \$300 million. Instead of using scrubbers in the smoke stack of the generating station to reduce emission of pollutants, Penelec will remove considerable sulfur from the coal before it is burned. The coal will be crushed and passed through two washing processes, involving centrifugal force and use of magnets, before final separation. But the second step at the Penelec cleaning plant is vital for power companies because it separates the coal into two streams. One stream that emerges will be low-sulfur coal, with a 0.8% or less sulfur content; the second will be moderate-sulfur coal with about 2.2% sulfur content. Once the coal is dried, it will be pulverized to the consistency of corn meal. Then the low-sulfur coal will be conveyed to the generating station now under construction. The moderate-sulfur coal will be conveyed to two 600,000-kilowatt generating stations that Penelec has operated in Homer City since 1969. EPA regulations allow stations in operation before 1974 in the Southwest Air Basin to burn coal with a sulfur content of between 1.8 and 3% without scrubbers. Penelec officials expect to process annually 1.3 million tons of low-sulfur coal and 3.5 million tons of moderate-sulfur coal.

Pennsylvania Power and Light Co. (PP&L) has also taken steps to reduce the sulfur content of coal prior to use in company-owned power stations. Greenwich, an operating unit of Pennsylvania Mines Corp., a subsidiary of PP&L, has added twin fine-coal-cleaning circuits using Batac jigs to an existing coarse-coal preparation plant. The Batac jigs are the first such units

purchased for application in the United States from the German manufacturer Humboldt-Wedag.

The U.S. Supreme Court refused to consider an appeal of the West Penn Power Co., which sought an injunction against a pollution control order affecting its Mitchell power station in Washington County. The case involved sulfur dioxide emissions from the plant.

Firestone Tire and Rubber Co. signed an agreement with Pennsylvania State officials allowing it to experiment with burning high-sulfur coal in a boiler at its tire and plastics manufacturing complex in Pottstown. The pilot plant program is designed to evaluate a chemical wet-scrubbing device for the removal of sulfur dioxide and particulate emissions.

The Federal Bureau of Mines signed a \$12.7 million cost-sharing agreement with St. Joe Minerals Corp. to demonstrate the Bureau's citrate process for scrubbing sulfur dioxide out of powerplant flue gas. The tests will involve the 50-megawatt boiler at St. Joe's George F. Weaton powerplant in Monaca.

Quality of approximately 900 miles of Pennsylvania streams improved in the period 1971-75, whereas 200 miles of stream were upgraded for a net gain in water quality of 700 miles. This information is contained in "Commonwealth of Pennsylvania 1976 Water Quality Inventory" prepared by DER's Bureau of Water Quality Management. The annual report on water quality also states that an overall average of 80% of the State's major streams through five drainage basins are in compliance with State water quality standards. Degree of compliance ranges from 98% in the Potomac River Basin to 72% in the Delaware River Basin. The Susquehanna and Ohio Basins each show 80% compliance and the Lake Erie Basin, 82%. DER estimates that by 1983, 2,253 miles of major streams will fail to meet established water quality goals. Mine drainage from abandoned mines, acting either alone or in combination with other pollution sources, accounts for more than 85% of this problem. The estimated cost of abating mine drainage problems is \$1 billion.

Construction is underway at the new Ernest acid mine treatment plant at Creekside, Indiana County. This project will restore more than 27 miles of Crooked Creek

and improve water quality in Crooked Creek State Park Lake, Armstrong County.

Completion of a \$389,553 mine drainage pollution abatement project in Little Toby Creek Watershed, south-central Elk County, was announced recently by DER. Reclaiming and revegetating strip mines and coal refuse areas in the watershed is expected to reduce the acid load entering the Little Toby Creek by an estimated 1,300 pounds per day, thereby improving the water quality both of Little Toby Creek and of Toby Creek to its confluence with Clarion River.⁷

The Rausch Creek acid treatment plant near Valley View, Schuylkill County, was dedicated September 18. The plant can treat 20 million gallons of acid-polluted water per day, which would eliminate the flow of polluted water into the Susquehanna River through the Little Mahantango Creek. This stream has been returned to the list of those that the Pennsylvania Fish Commission annually stocks with trout.⁸

A 13-acre area in Forbes State Forest, Ogle Township, Somerset County, is being reclaimed. Under a 1973 agreement between PBS Coals, Inc., Mercersburg, the DER, and members of the Gould family, the company was allowed to surface mine on portions of the Forest in return for reclamation of previously stripped lands. As a result of the recently completed mining, the abandoned deep mine was removed completely and further acid discharges were eliminated.⁹

Beaver Contracting & Excavating Company of Rochester was awarded a mine drainage pollution abatement demonstration project at Hillman State Park at the northern end of Washington County. The project called for moving about 1.2 million cubic yards of dirt on an area that had been strip mined, and specially treating the surface of the reclaimed area with fly ash prior to reseeding. The pilot project uses fly ash to control the pH level of the soil and make it a better medium for seeding purposes.

DER moved closer to ending pollution in Westmoreland County waterways with the completion of a \$27,845 project in Salem and Washington Townships. To reduce acid mine drainage into Thorn Run, which flows into Beaver Run Reservoir, DER financed the dismantling of a dilapidated coal sorting and cleaning building; regrading, covering, and seeding a spoil pile; seal-

ing a mine opening and two sink holes; and constructing a stream channel.

DER awarded a \$1.5 million contract to No. 1 Contracting Corp., West Pittston, for the hydraulic flushing of mine voids in Plymouth. The project involves flushing mine voids in the Stanton, Five Foot, and Baltimore veins of the abandoned Nottingham Colliery. In addition to drilling boreholes through which the material will be pumped, the project also involves flushing the mine voids with 464,400 long tons of crushed breaker refuse. Seventy-five percent of the costs will be financed through the Appalachian Regional Development Act of 1965; the remaining 25% will be financed by the State.

A \$220,000 Federal-State project aimed at controlling water buildup in the No. 3 slope mine of Hegins Mining Co. in Schuylkill County has been approved by the Department of the Interior. This is one of several interconnected mines in Porter Township that has been troubled by water seeping from one mine into another after heavy rains. The project will involve installing a high-volume, deep-well pump at the No. 3 slope mine, which has been flooded on several occasions. The pump will be provided by the State of Pennsylvania and installed by State contract in a well yet to be drilled. Installation of the pump is expected to keep the mine dry even in periods of heavy rainfall.¹⁰

The Luzerne County Commissioners approved sealing the opening of an abandoned mine shaft in the Miners Mill section of Wilkes-Barre.

On March 2 the Commonwealth Court ruled that Barnes and Tucker Coal Co., Johnstown, must pay for treating all acid mine water draining from its abandoned Lancashire No. 15 mine, near Barnesboro, Cambria County. Acid mine water had been flowing from the mine since 1970, and State courts were hearing the case for a 5-year period.

The Laurel Creek Watershed Association, Somerset County, is opposed to proposed surface mining and construction of powerplants in the Laurel Hill Creek Watershed. Proposed State regulations list this watershed as a restricted area and deny issuance

⁷ Pennsylvania Econotes, November 1976.

⁸ Pennsylvania Econotes, October 1976.

⁹ Pennsylvania Econotes, January 1976, p. 9.

¹⁰ U.S. Department of the Interior, News Release, June 17, 1976.

of mining permits, but experimental permits may be issued.

Pennsylvania has apparently won its case for stricter pollution controls along Ohio's Mahoning River, which flows into Pennsylvania and supplies drinking water to communities in Beaver County. The Environmental Protection Agency said that all steel mills in the Mahoning River Valley would have to meet all Pennsylvania water quality standards before pollution-discharge permits are issued.

The "Public School Code of 1949," as amended, requires that any school district or authority planning to construct or reconstruct a school building in an area certified by DER to be subject to mine subsidence, shall, before beginning to design, obtain a DER evaluation of the substrata of the land upon which it will be situated. As to any school building, construction or reconstruction project of the type covered by this act, the design for which has already been completed but as to which actual construction has not yet commenced as of the effective date of this act, the involved school district or authority shall also obtain the substrata evaluation required before beginning actual construction.

Subsidence damaged facilities in the Belle Vernon School District for the second time this year, temporarily closing part of the newest edition to Marion Elementary School in Washington Township, Fayette County. Previous subsidence had occurred at the Bellmar Junior High School. Over the past decade, abandoned mines have caused other subsidence problems in the North Belle Vernon Borough area.

Consolidation Coal Co. (Consol) agreed to fill in a mine subsidence hole in South Park and repair the surface of the parking lot where the cave-in occurred. Consol's Montour No. 10 mine had been extracting coal in the general area at the time subsidence occurred.

Harrison Township officials questioned mine subsidence regulations and were told that insurance will cover subsidence caused by underground mines, but coverage is not applicable for change in strata caused by soil conditions.

The Federal National Mortgage Association (FNMA) adopted new requirements designed to alert the home building industry of potential subsidence problems in western Pennsylvania. The FNMA never

had subsidence requirements, but through a ruling, now requires written proof from environmental agencies and coal companies that the site will not have subsidence.¹¹

Electricity.—Pennsylvanians used a record 92.1 billion kilowatt-hours of electricity in 1976, compared with 87.6 billion kilowatt-hours in 1975. Pennsylvania's use of electricity has increased more than 60% in the past 10 years, while generation of electric power increased 71%. Projections show use of electricity in Pennsylvania will be 70% greater in 1985 than in 1975. Business and industry account for over two-thirds of Pennsylvania's consumption of electricity, with residential use accounting for 30% of the total. In the future, industry will continue to take the principal share of electricity, with residential and commercial users consuming electricity at a slower growth rate.¹²

In 1975, 92% of the kilowatt-hours produced by PP&L were derived from coal, and 5% came from oil-fired equipment. Cost to produce 1 kilowatt of electricity in 1975 was 2.8 cents, with company projections of 4 cents in 1980 and 5 cents by the mid-80's. During the period of April to June 1976, coal was used to generate 94.8% of all PP&L electricity at an average fuel cost of 1.10 cents per kilowatt-hour. During this 3-month period, the average cost for purchased coal rose 45 cents per ton, from \$26.59 to \$27.04. Residual oil used at other generating plants increased 18 cents per barrel to \$12.01, and light oil increased one-tenth of 1 cent to 31.9 cents per gallon.

PP&L's Susquehanna Steam Electric Station, in Salem Township, Luzerne County, is the company's first nuclear powerplant with twin 1,050-megawatt generating units scheduled for completion in 1982. The \$2 billion complex was 20% completed at the end of the year.

Metropolitan Edison Co.'s Three Mile Island atomic plant south of Harrisburgh will install a charcoal filter in the containment vessel to reduce the amount of radioactive iodine, which is routinely released into the atmosphere in the form of gases. The Three Mile Island nuclear plant was idle from February 20 to April 26 for refueling. Fifty-six of the fuel assemblies were

¹¹ Pennsylvania Econotes. January 1976.

¹² Pennsylvania Electric Association. Facts You Should Know About Electric Power in Pennsylvania—1976.

replaced and maintenance work was completed on the reactor vessel.

Westinghouse Electric Corp. agreed in April to deliver 124,000 pounds of uranium to three utility companies operating a Beaver County nuclear reactor. Westinghouse had informed its nuclear-generating companies that it could not meet contractual obligations reached in 1969, but a preliminary injunction filed in late 1975 by the three firms, was necessary to obtain the fuel.

One of the Philadelphia Electric Co. (PEC) Peach Bottom nuclear units was taken out of service on May 25 because of an electrical problem and restored to service June 1. The unit provided about 8% of the 1975 utilities electric output. The second Peach Bottom unit closed March 31 for annual maintenance and refueling; operation will resume in late June.

In Beaver County, Duquesne Light Co. was constructing three nuclear-fueled power stations, and PPC was building the three-unit Bruce Mansfield coal-fired complex.

Transportation.—PP&L leased its ninth unit train for hauling coal between Pennsylvania mines and PP&L generating plants. The cars are loaded every 2 or 3 days, which usually allows 2 days of travel time and 6 hours for loading and between 4 and 8 hours for dumping at the powerplants. Roundtrip mileage averages between 400 and 500 miles. The most recent acquisition of Train No. 9 brings the company fleet to a total of 997 hopper cars. These cars are loaded at any of the 12 present coal suppliers in central Pennsylvania, including 4 company-owned mines, and can make delivery to 3 of the company's coal-fired steam electric stations, Montour, Brunner Island, and Martins Creek.

The Economic Development Council of Northeastern Pennsylvania received a \$37,334 grant to conduct a study to determine the feasibility of short railroad lines and other alternatives to maintain essential branch-line service through northeastern Pennsylvania.

Consolidated Rail Corp. (ConRail) has been rehabilitating tracks in Pennsylvania.

Two crews spent the summer replacing cross ties between Wilkes-Barre and White Haven and the Poconos. Welded rail will be installed between White Haven and Laurel Run. In addition, welded rail has been replaced in the Allentown-Bethlehem area. ConRail operates 35,000 miles of track in the northeastern part of the United States.

Governor Shapp and the Volkswagen Corp. signed an agreement to establish an auto assembly plant at New Stanton, east of Pittsburgh. Part of the financial arrangements include \$30 million in State appropriations, mostly for a railroad and highway link to the plant. The money has been approved by the State Legislature.

Governor Shapp also signed legislation that will permit the continued operation of about 700 miles of railroad lines that could have been abandoned under the Federal rail reorganization plan. The bill permits the State to subsidize operation of the lines, most of which are spurs in the eastern and northeastern part of the Commonwealth.

The Pittsburgh and Lake Erie Railroad (P&LE) won trackage rights to operate its trains to Lake Erie under final plans of the United States Railroad Association (USRA) and its reorganization of bankrupt northeast lines. P&LE, a carrier of iron ore to Pittsburgh area steel mills, will have assured access to loading docks at Ashtabula, Ohio, under the agreement granting it the right to use former Penn Central tracks at Youngstown, Ohio. P&LE serves steel mills in the Aliquippa, Pittsburgh, and Monessen areas, other than those of U.S. Steel which controls the Union Railroad.

Many railroads were affected by a 24-day coal strike that started on July 19 in West Virginia. The Chessie System furloughed more than 1,000 employees mainly in West Virginia. P&LE furloughed 100 employees. ConRail lost revenue of approximately \$6 million since the strike started. The Bessemer and Lake Erie Railroad, a subsidiary of U.S. Steel, hauling ore and limestone south from Conneaut was not affected by the strike.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Anthracite).—Production decreased for the 12th consecutive year to 5.3

million tons according to DER. Strip mine production totaled 2.9 million, nearly 18% higher than in 1975; however, decreases of 28% occurred in bank production and 13%

in deep-mine production. The leading counties, in descending order of production, were Schuylkill, Luzerne, Northumberland, Carbon, Lackawanna, Columbia, Sullivan, Dauphin, and Susquehanna. Deep-mine production occurred only in Schuylkill, Northumberland, Columbia, and Dauphin Counties. Employees totaled 3,641, 6% fewer than in 1975.

Of the 4.8 million tons of anthracite shipped to market, 38% was by rail and 62% was by truck. Less than 500,000 tons was sold locally for space heating, and less

than 10,000 tons was used at the mine site for steam and heating purposes.

Leading producers of anthracite were as follows, in descending order with production in short tons in parenthesis: Jeddo-Highland Coal Co. (787,774), Reading Anthracite Co. (545,983), Bethlehem Mines Corp. (468,817), Beltrami Enterprises, Inc. (277,320), Leon E. Kocher Coal Co. (267,129), Heckla Machinery and Equipment Co. (262,969), Ken Pollock, Inc. (132,667), Swatara Coal Co. (132,046), and Gilberton Coal Co. (131,057).

Table 4.—Pennsylvania: Production of anthracite coal and number of employees, in 1976, by county

County	Production (short tons)				Number of employees				
	Deep mines	Bank mines	Strip mines	Total	Deep mines	Bank mines	Strip mines	Breaker and washery	Total
Carbon	---	180,822	75,133	255,955	---	13	48	---	61
Columbia	36,529	---	31,059	67,588	50	---	42	---	92
Dauphin	8,574	16,678	---	25,252	15	3	---	20	38
Lackawanna	---	93,664	11,764	105,428	---	19	5	61	86
Luzerne	---	401,062	1,013,245	1,414,307	4	81	884	311	780
Northumberland	61,792	392,800	262,315	716,907	129	14	187	171	501
Schuylkill	409,460	729,894	1,507,246	2,646,600	531	174	692	648	2,045
Sullivan	---	---	57,353	57,353	---	---	23	10	33
Susquehanna	---	2,386	---	2,386	---	1	---	5	6
Total	516,355	1,817,306	2,959,115	5,291,776	729	305	1,381	1,236	3,641

Source: Pennsylvania Department of Environmental Resources, 1976 Annual Report on Mining, Oil and Gas, and Land Reclamation and Conservation Activities.

PP&L is considering low-sulfur anthracite for power generation. Four 400,000-kilowatt generating units would be operational in 1985 and consume 4 million tons of anthracite yearly.¹³

Tuscarora Coal Corp. will build and operate an anthracite preparation plant slated for construction in Schuylkill County. The treatment plant will be constructed near Pottsville as a joint venture between Glen-Gery Corp., a manufacturer of brick, and Gale Coal Co.; it will employ heavy-media equipment. The joint venture was formed to mine and process anthracite in a plant with a rated capacity of 125 tons per hour, equivalent to about 350,000 tons per year. About 80,000 tons of the anthracite will be used internally by Glen-Gery; the balance will be sold on the open market. Glen-Gery has used anthracite to produce low-Btu gas for its brickmaking operations since 1950 and, with construction of the Tuscarora preparation plant, will meet its energy requirements from anthracite.

Two new surface coal-stripping operations were started in Newport Township by Beltrami Enterprises. The first surface mine is at Stearns Station; the second is in the Retreat Mountain area north of Glen Lyon. Coal produced from the Ross Vein will move to plants in Nanticoke and Ashley before it is sent to the Huber preparation plant. In late July, 400 employees at Humboldt, Oneida, and Wyoming Valley breakers were furloughed due to a seasonal adjustment of anthracite coal stocks. A month later, the Huber Colliery, in Ashley, was dismantled and the four-story structure cut up for scrap.

Businessmen from the Scranton and Reading area purchased for \$2.5 million approximately 5 million tons of culm in the Mocanqua area from Carrier Coal Enterprises. Coal will be recovered from the culm banks and marketed in the area.

In January 1976, the Governor's Science Advisory Committee published a report, "Recommendations on a Feasibility Analysis." The report focuses on open pit anthracite mining with full restoration to a desirable land use, as an alternative to conventional deep-mining systems.¹⁴

The retired president of the Reading Anthracite Co. and a representative of the Smithsonian Institute wrote an article, "Our Oldest Coal Town." The article pinpointed Wilkes-Barre as the Nation's old-

est, continuously operating coal town and described the history of the anthracite industry in northeastern Pennsylvania.

In late November, a large block of anthracite coal measuring 9 feet by 12 feet and 5 feet high was mined in Bethlehem Mines Corp.'s Panther Valley Division, transported to Our Lady of Mt. Carmel Church in Nesquehoning, Carbon County, and placed outside the church to memorialize those who have lost their lives in anthracite mines. This block of coal is believed to be the largest single chunk of coal brought to the surface intact.

In Wilkes-Barre, anthracite was again ignited at the historic grate of the former Old Fell House, now known as The Tavern. This 168th anniversary commemorates Judge Jesse Fell's findings on February 11, 1808, that anthracite could be used as a household fuel.

A Federal grand jury indicted six Pennsylvania coal companies on charges of conspiring to fix hard-coal prices during a 13-year period. The indictment, returned in Federal Court in Harrisburg, named Blue Coal Corp., Ashley; Glen Burn Colliery Inc., Mt. Carmel; Greenwood Stripping Co. and Lehigh Navigation-Dodson Co., both of Bethlehem; and Lehigh Valley Coal Sales and Reading Anthracite Co., both of West Pittston. As a result of the conspiracy, prices for hard coal were maintained at "artificial and noncompetitive" levels and competition in the industry has been restrained, the indictment contends.

Coal (Bituminous).—Pennsylvania, the third largest bituminous coal-producing State, produced 85.7 million tons, 2% more than in 1975. Production decreases occurred in deep-mined coal, auger production, and refuse production, but strip-mined coal increased 7% compared with the 1975 level. The total number of mining operations increased from 1,740 in 1975 to 1,913 in 1976. The addition of 4 underground mines brought the total deep mines to 159; 11 additional auger operations resulted in a total of 64; and refuse operations remained at 16. The greatest increase occurred in surface mining operations with an increase of 168 which brought the total to 1,498.

Consol's new Westland No. 2 mine located near Westland, Washington County,

¹³ Mining Congress Journal, December 1975, p. 12.

¹⁴ State of Pennsylvania, Governor's Science Advisory Committee, Recommendations on a Feasibility Analysis, January 1976.

Table 5.—Pennsylvania: Production of bituminous coal, number of employees, and number of operations, in 1976, by county

County	Production (short tons)				Number of employees				Number of operations					
	Deep	Strip	Auger	Refuse	Total	Deep	Strip	Auger	Refuse	Tipple and preparation plants	Total	Deep, strip, and auger mines	Refuse piles	Tipple and preparation plants
Allegheny	3,321,317	577,234	--	26,000	3,924,551	1,594	149	--	10	220	1,973	38	1	6
Armstrong	4,246,880	3,393,943	86,578	--	7,727,401	1,184	579	34	--	123	2,225	145	--	16
Beaver	82,315	105,737	--	--	188,102	181	99	--	--	10	160	5	--	2
Bedford	--	104,256	--	--	104,256	--	69	--	--	--	69	7	--	2
Blair	--	1,088	--	--	1,088	--	8	--	--	6	9	1	--	1
Bradford	50	--	--	--	50	1	--	--	--	--	--	--	--	--
Butler	250,657	1,060,253	14,809	--	1,395,729	218	253	5	--	42	518	1	--	1
Cambridge	5,027,225	2,131,208	--	725,900	7,884,333	4,211	935	--	112	385	5,346	80	8	8
Centre	602,364	612,077	9,492	--	1,224,941	281	184	--	--	70	455	20	--	14
Clarion	5,187,379	5,187,011	--	--	10,374,390	1,083	10	10	--	187	1,205	143	--	6
Clearfield	651,446	7,630,447	28,843	--	8,310,736	225	1,896	15	--	215	2,291	268	--	15
Cleburne	--	390,768	--	--	390,768	--	127	--	--	9	136	17	--	2
Elk	--	664,630	9,650	--	7,267,260	108	108	8	11	6	122	36	--	2
Fayette	753,389	2,318,631	--	54,705	3,126,725	472	550	--	--	239	1,272	130	4	8
Fulton	6,892,325	1,092,546	--	--	7,984,871	3,855	234	--	--	232	4,354	2	--	4
Greene	--	4,000	--	--	4,000	--	4	--	--	--	4	2	--	--
Huntingdon	8,138,008	2,592,088	92,005	50,025	10,802,339	4,639	575	25	8	246	5,493	166	1	15
Indiana	81,068	2,404,103	2,561	--	2,487,802	50	513	3	--	51	617	100	--	11
Jefferson	--	671,946	17,580	--	689,523	--	137	9	--	4	160	29	--	1
Lawrence	--	50,187	--	--	490,197	--	71	--	--	27	98	6	--	2
Luzerne	--	399,737	--	--	399,737	--	46	--	--	11	57	7	--	2
Mercer	2,681,453	3,663,763	41,297	--	6,386,533	1,332	1,003	18	--	324	2,744	207	--	24
Monroe	--	823,563	--	--	823,563	--	103	--	--	8	111	7	--	1
Toledo	--	840,568	--	--	840,568	--	93	--	--	--	93	19	--	1
Washington	10,799,322	1,646,302	--	--	12,445,624	5,141	362	--	--	231	5,734	61	--	7
Westmoreland	800,041	1,987,197	9,183	7,842	2,804,263	405	517	3	13	61	999	111	2	3
	44,328,580	40,242,401	312,421	864,472	85,747,874	24,079	9,215	130	154	2,662	36,240	1,721	16	176

¹ Twenty-three workers were employed at coke operations.

Source: Pennsylvania Department of Environmental Resources, 1976 Annual Report on Mining, Oil and Gas, and Land Reclamation and Conservation Activities.

which was scheduled to open in 1978, would produce 250,000 tons per year of steam coal for utility customers. Coal from the two planned continuous-miner sections will be cleaned at Consol's Champion preparation plant.

Bethlehem Mines Corp. began producing coal from mine 38E located near Ehrenfeld on September 1, 1976, from the Upper Freeport seam. By 1978, production is expected to reach 400,000 tons per year of low-volatile metallurgical coal.

Gulf + Western was in the process of acquiring a controlling interest in Solar Fuel Co. located near Somerset.

Consolidation Natural Gas Supply Co. (CNG) based in Clarksburg, W. Va., purchased more than 6,700 acres of coal in western Greene County for probable use in a projected coal gasification plant. The coal, located in Aleppo Township, was sold to CNG by the Manor Real Estate Co., a subsidiary of the Penn Central Co.

The Greene County Commissioners executed a sales contract in early April with Henderson Mining Co., the coal-buying division of Jones and Laughlin Steel Corp. (J&L), for sale of 430 acres of Freeport coal underlying county-owned property in Franklin Township. J&L will be the first company to mine the Freeport seam in Greene County. Coal will be moved from the mine by conveyor belt to the Monongahela River for barge shipment to the Pittsburgh area. Henderson Mining Co. has already acquired 37,000 acres of Freeport coal near Waynesburg for future development.

In early January, Lykes-Youngstown Corp. arranged financing of the Emerald mine No. 1, expected to cost \$70 million, with production beginning in late 1976. Two million tons per year of high-grade metallurgical coal is anticipated by 1979.

Two affiliates of PP&L, the Greene Manor Coal Co. and the Greene Hill Coal Co., purchased coal properties in Greene County from Manor Real Estate Co., Hillman Coal and Coke Co., and West Properties Trust. Greene Manor Coal Co.'s purchase of 497 acres in Center Township in late January brings the total acreage owned to 12,107 acres of Pittsburgh Coal; Greene Hill Co.'s purchase of 98 acres in Center and Gray Township brings its total to 30,993 acres. With these purchases, PP&L plans to increase its coal reserves.

Pennsylvania Mines Corp., a subsidiary of PP&L, announced in early March as-

sumption of ownership of the Oneida Mining Co. from the parent company, the North American Coal Corp., according to a 1970 contract between the two parent companies. PP&L also owns Greenwich Collieries, Rushton Mining Co., and Tunnelton Mining Co., all suppliers of coal for PP&L's powerplants.

Quaker State Oil Refining Corp. of Oil City acquired the Valley Camp Coal Corp., a company based in Cleveland, Ohio, with coal properties in West Virginia. Under terms of the merger, a maximum of 3.16 million shares of Quaker State stock is issuable to shareholders of the Valley Camp Coal Corp.

The Donora Borough Council plans to sell 120 acres of Freeport coal beneath Palmer Park to Consolidation Coal Co. The Freeport seam is located approximately 900 feet below the surface.

Royal Resources, a Fairmont, W. Va., firm purchased three tracts of land totaling 210 acres in Whitely Township, Greene County, and all coal seams except the Pittsburgh bed.

U.S. Steel's Cumberland mines at Kirby, Greene County, began operations in November. All the coal from the mine will be shipped to a powerplant in Ontario, Canada, under a 30-year contract.

Although employment increased 6% to 36,240, the number of employee-days worked throughout the bituminous region increased nearly 4%, indicating additional lost time by unauthorized work stoppages.

In early August, after a 4-week strike, coal miners in the Appalachian area returned to work. The dispute began July 19 at a Cedar Coal Co. mine in Kanawha County, W. Va., near Charleston, and pickets spread the strike throughout the Appalachian region. The executive board of the United Mine Workers of America (UMWA) met in Charleston, W. Va., in early August and voted for an immediate end to the walkout and expulsion of any workers from the UMWA refusing to return to work.

Of the 36,240 employees in the bituminous region, 57.6% were classified as inside employees and 42.4% as outside employees. Nearly 69% of the inside employees were classified as mechanical loading, 31% as all other occupations, and less than 1% as shot firers, pick miners, cutting-machine operators, and hand-loading miners.

Washington, Indiana, Greene, Cambria, and Armstrong Counties produced 35.10 million tons or 79.2% of its total deep-mined coal. Clearfield, Clarion, Somerset, Armstrong, and Indiana Counties produced 22.40 million tons, or 55.6% of the total strip-mined coal. Indiana, Armstrong, Somerset, and Clearfield Counties produced 80% of the total auger-mined coal. Cambria County produced 84% of the coal reclaimed from refuse piles. Collectively, Washington, Indiana, Clearfield, Greene, Cambria, and Armstrong Counties produced 55 million tons, or 64% of the State's total bituminous coal production, and had 25,443 employees or 70% of the total employees of the State's bituminous coal industry.

Table 6.—Pennsylvania: Value of bituminous coal, by county, in 1976

County	Value (thousands)
Allegheny	\$111,205
Armstrong	147,604
Beaver	4,085
Bedford	W
Blair	W
Butler	29,108
Cambria	284,363
Centre	24,058
Clarion	90,079
Clearfield	172,076
Clinton	6,889
Elk	11,594
Fayette	64,037
Fulton	W
Greene	257,843
Huntingdon	W
Indiana	245,554
Jefferson	48,019
Lawrence	10,772
Lycoming	W
Mercer	7,940
Somerset	152,455
Tioga	W
Venango	14,506
Washington	414,651
Westmoreland	59,783
Undistributed	16,407
Total ¹	2,173,009

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

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

A 12-million-ton-per-year coal transfer facility will be built in Duquesne for the Union Railroad. The \$4 million to \$5 million project was scheduled to be completed in early 1978.

The State of Pennsylvania planned to purchase 365,700 tons of coal during the year for State buildings. Savings of over \$4 million will be realized through use of less expensive bituminous coal instead of

the higher priced anthracite. Starting July 1, the State will pay an average of \$37.30 per ton of anthracite delivered to State institutions, down \$11.60 from the current price; and bituminous will cost \$24.30, down \$11.46 from the cost in previous years.

The \$36 million coal gasification plant dedicated in early September near Homer City, Indiana County, produces synthetic fuels from coal. The Bi-Gas facility using the Bituminous Coal Research Inc. process produces 2.4 million cubic feet of pipeline-quality methane gas daily using 120 tons of coal. The Indiana County plant is the largest in the United States, and total project cost is estimated at \$66 million.

Westinghouse Electric Corp.'s Waltz Mill site in Westmoreland County will be used to convert high-sulfur coal to a clean, low-heat gas for electric power generation. By the early 1980s, the Waltz Mill plant will be using 50 tons of coal per hour to produce the gas. Currently, small amounts of coal have been processed at the plant without the need for pretreatment.¹⁵

Coke.—Output of 16.2 million tons of coke, valued at \$1.4 billion, ranked Pennsylvania first in national output and value.

J&L's A-5 battery at its Aliquippa Works is one of the newest and most modern coke plants in the Nation. A hot coal slurry, isolated from the atmosphere, to reduce air pollution is directed to 56 coke ovens. Coking time per oven is also reduced from 17 hours to 11½ hours. Time is saved by flash drying the wet crushed coal and heating the coal to 450°F. The Aliquippa Coke Battery is the fourth in the Nation to use pipeline charging and only the second to use the whole system. The first coal at Aliquippa was processed in early January with a full annual production rate of 1 million tons by late summer.

U.S. Steel announced in early June a proposed reduction in coke output at the Clairton works from a current 7½ million tons to about 5 million tons due to excessive modernization costs to meet environmental standards.

The Labor Department issued new regulations in early October to protect workers from coke oven emissions, ordering employers to make specific engineering and work rule changes. Under the new rules, coke-oven workers will not be allowed to work in factory air containing more than

¹⁵ Mining Congress Journal, November 1976, p. 11.

0.15 milligram of benzene-soluble particulate emissions per cubic meter of air, averaged over 8 hours. The new rules also cover medical examinations and special respiratory equipment for workers.

Peat.—Peat was produced by seven companies at eight operations in five counties. Three peat-producing operations were located in Luzerne County and one each in Erie, Lackawanna, Lawrence, and Monroe Counties. In the western part of the State, peat was produced near Leesburg, Lawrence County, by D. M. Boyd Co. and by the Corry Peat Products Co., near Corry, Erie County. Production in the eastern part of the State was near White Haven, Luzerne County, by International Peat, Inc., and near Thornhurst, Monroe County, by Pennsylvania Peat Moss, Inc.

Of the total peat produced, 92% was classified as humus, 6% reed sedge, and the remaining 2% as moss. Peat is used mainly for general soil improvement.

Petroleum and Natural Gas.—The American Petroleum Institute reported a total of 1,262 oil and gas wells drilled for a total footage of 2,856,697 feet compared with 1,399 wells and 3,353,341 feet in 1975. Of the total wells, 1,191 were in proved fields; 641 classified as oil, 535 gas, and 15 as dry. The 71 remaining wells were exploratory, 10 were drilled for oil, 30 gas, and 31 were listed as dry.

Indiana County led all other counties in the total number of wells drilled with 257, of which 254 were in proved gasfields. Venango County followed with 238 wells, all but 2 being drilled in proved oilfields. Other leading counties were Warren, McKean, and Forest.

UGI Corp. announced in early February a \$6 million drilling program for natural gas in western Pennsylvania. Drilling was planned to begin in early April with ex-

pected gas deliveries from these fields by November. UGI has gas leases on approximately 50,000 acres of land in Forest and Warren Counties. During 1975, 12 wells were drilled on these properties.

Equitable Gas Co. plans to allot one-third of its \$30.5 million budget for drilling and connecting new gas wells and to stimulate production from old wells. Equitable's subsidiary, Kentucky West Virginia Gas Co., plans to drill 30 new wells; 12 will be drilled deeper; and 40 existing wells will be connected.

Peoples Natural Gas Co. plans to accelerate its activity in the search for gas. Currently, the company has 1,275 wells and 2,800 outside connections. Half of Peoples' \$12.8 million budget will go for an 83-well program to explore and to continue increased production of Appalachia gas. Peoples' 1975 record of 28.6 billion cubic feet of gas produced and purchased was expected to be surpassed in 1976.

The U.S. Geological Survey, under a 5-year program will assess the gas potential of black shales of Devonian age that underlie an area of more than 160,000 square miles in the Appalachian basin. The Devonian shales, a sequence of fine-grained black, brown, and dark gray organic rich bituminous rocks, range in thickness from less than 25 feet in parts of Alabama and Georgia to more than 1,500 feet in parts of Pennsylvania.¹⁶

Degasification of coal seams will also help to ease the natural gas shortage. Gas from the coal seam of the Emerald Mines Corp. will flow into the pipelines of Equitable Gas Co. by yearend.

On February 16, Governor Shapp announced his decision to end the 8-year ban on natural gas drilling in Lake Erie.

¹⁶ U.S. Department of the Interior. News Release, Mar. 31, 1976.

Table 7.—Pennsylvania: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Allegheny	--	--	--	--	1	--	1	3,631
Armstrong	1	67	2	--	--	--	70	234,262
Beaver	--	--	--	--	1	--	1	6,666
Butler	1	--	--	--	--	2	3	4,283
Cambria	--	--	1	--	--	--	1	4,011
Clarion	4	7	1	1	--	2	15	37,496
Clearfield	--	17	1	--	11	--	31	127,024
Clinton	--	2	--	--	--	1	3	4,618
Crawford	11	6	1	--	4	2	24	89,974
Elk	3	3	1	--	--	1	8	15,082
Erie	--	13	--	--	1	2	16	51,165
Fayette	--	--	--	--	--	2	2	7,090
Forest	87	8	3	2	1	4	105	147,998
Indiana	--	254	1	--	1	1	257	909,439
Jefferson	--	70	--	--	4	1	75	242,230
Lawrence	--	1	--	--	--	--	1	906
Lycoming	--	--	--	--	1	--	1	6,325
McKean	108	3	--	3	--	2	116	217,013
Mercer	--	--	--	--	1	1	2	9,646
Potter	4	--	--	--	--	--	4	5,453
Somerset	--	--	--	--	--	1	1	3,501
Tioga	--	--	--	--	--	1	1	4,660
Venango	236	--	1	1	--	--	238	184,151
Warren	186	1	1	3	--	2	193	206,917
Washington	--	7	1	--	1	--	9	30,557
Westmoreland	--	76	1	--	3	4	84	302,599
Total	641	535	15	10	30	31	1,262	2,856,697

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

The extremely cold weather in January and February caused many problems in Pennsylvania. Frozen rivers in the Pittsburgh district prevented barge shipments of coal and fuels urgently needed by industry and local citizens. Due to the high consumption of natural gas, shortages occurred resulting in curtailments by the utilities. Equitable Gas Co. was the first to order rationing, labeling the situation an emergency and ordering its industrial customers to stop production. Columbia Gas Co. imposed the same curtailments and asked residential customers to lower thermostats to 65° F or lower. Peoples Natural Gas Co. asked 205 industrial customers to reduce gas use for the duration of the cold weather and ordered schools served by the company to close. The steel industry reacted by shutting down operations for which they could not find substitute fuels which resulted in thousands of idled workers in the Pittsburgh area. Governor Shapp ordered all public and private schools closed from January 26 through February 2 to save dwindling supplies of natural gas and to avert possible cutoff to residential customers. The Governor also ordered all public schools in the State heated

by natural gas to remain closed through February 1, but those heated by other fuels were free to reopen.

Pittsburgh public and parochial schools and nearly all school districts in western Pennsylvania not served by Columbia Gas Co. were scheduled to reopen on February 7 with lowered thermostats, which curtailed schedules and practically eliminated afterschool activities. Schools served by Columbia Gas Co. were scheduled to reopen on February 9, but with more stringent restrictions.

In Philadelphia, PEC in early February cut natural gas supplies to plant maintenance levels for all of its suburban industrial customers and commercial users who normally receive 50,000 cubic feet per day. Previously PEC, which serves 252,000 customers, made the same cuts to its 110 largest customers in Bucks, Chester, Delaware, and Montgomery Counties. Ten days later, the big industrial and commercial firms were allowed to reopen. Columbia Gas announced in early January a 35% curtailment to industrial customers beginning April 1 and continuing through October 31, with a 15% curtailment to commercial and a 10% curtailment to schools.

Consolidated Natural Gas announced in early March curtailment of gas to customers of more than 6% during the year. Other Pennsylvania gas companies reduced natural gas supplies to customers throughout the year.

In early February, CNG, parent firm of Peoples Natural Gas Co., announced that Sonatrach, Algeria's state-owned gas and oil company, will sell to CNG approximately 600 million cubic feet of natural gas, to be transported to the United States in liquefied form by tanker. CNG also planned to form a natural gas storage company in a joint venture with Texas Eastern Transmission Co. The storage company would in effect be the world's largest single storage field, containing 270 billion cubic feet of gas, located in north central Pennsylvania.

The price of Pennsylvania-grade crude oil increased \$1.82 per barrel to \$13.82 per barrel compared with the 1975 level. Principal buyers of Pennsylvania crude oil are Pennzoil, Quaker State, Wolfs Head, and Kendall.

Quaker State's four refineries, located in Pennsylvania and West Virginia, processed 7.3 million barrels of crude oil in 1974 and a lesser amount in 1975 due to a work stoppage at one refinery. Quaker State plans to spend \$16.5 million in 1976 for oil development and exploration.

The 84-mile oil pipeline from Marcus Hook to PP&L's Martin Creek Station was completed; initial pumping began on August 9. Martin Creek units 1 and 2 are coal-fired, but units 3 and 4, each rated at 800 kilowatts, will burn oil to provide needed generation capacity. The two new units were also provided with evaporative cooling towers to prevent discharge of heated water into the Delaware River.

NONMETALS

Cement.—Portland cement shipments from 16 plants in 8 counties were 3% greater in quantity and 10% greater in value than in 1975. The average unit value per short ton increased \$1.99 to \$30.92 compared with that of 1975.

Masonry cement shipments from 14 plants in 8 counties were 6% greater in

quantity and 15% greater in value, with an increase in unit value of \$3.59 to \$44.60 compared with the 1975 level.

Northampton and Lawrence Counties were the largest producers of both portland and masonry cements. Other producing counties include Allegheny, Berks, Butler, Lehigh, Montgomery, and York. Of the 5,989,337 tons of portland cement sold, 10.5% was used by building material dealers, 21.6% by concrete product manufacturers, 58.8% by ready-mix companies, 7% by highway contractors, 1.6% by other contractors, and less than 1% for government agencies and miscellaneous customers.

Consumption of energy for the 16 producing plants was 583,942,000 cubic feet of natural gas, 317 thousand 42-gallon barrels of fuel oil, 1.27 million tons of bituminous coal and 981,268,000 kilowatt-hours of electricity.

Major producers of portland and masonry cement include Amcord, Inc., Medusa Corp., National Gypsum Co., Penn-Dixie Industries, Inc., and U.S. Steel Corp. Coplay Cement Manufacturing Co. ordered a new cement kiln for its Nazareth plant. The kiln will have a capacity of 3,100 tons per day and will operate on the energy-saving heat-exchange principle.

Clays.—During the year, 68 clay operators, two fewer than last year, had operations in 26 of Pennsylvania's 67 counties, and produced 17% more in quantity and 16% more in value than in 1975. Unit price per ton was \$7.22, 3 cents less than in 1975.

Clearfield County, with 17 operations, was the leading producer with 567,651 tons valued at \$9,137,000. Other counties with a high production of clay included Beaver, Jefferson, Lawrence, and York.

Leading producers, in descending order of production, included Glen-Gery Corp., Veon, Talph A. Inc., Dresser Industries, Inc., Reese Bros., Hanley Co., and Darlington Brick and Clay Products Co.

Clays were used mainly for common and face brick, firebrick, and portland and other cements. Other minor uses included flue linings, high-alumina refractories, pottery, sewer pipe and drain, and quarry and structural tile.

Table 8.—Pennsylvania: Clays sold or used by producers, by use¹
(Short tons)

Use	1975	1976
Common brick -----	68,549	192,506
Face brick -----	851,421	862,955
Firebrick, block and shapes -----	646,602	681,675
Flue linings -----	41,421	98,807
Lightweight aggregates -----	40,000	13,642
Mortar and cement, refractory -----	16,378	30,675
Paint, pesticides, rubber, other fillers -----	2,797	W
Portland and other cements -----	108,675	149,774
Sewer pipe -----	W	W
Tile:		
Floor and wall, ceramic -----	4,300	--
Drain, quarry, structural -----	50,671	56,910
Other uses ² -----	65,696	111,730
Exports:		
Refractories -----	48,791	97,812
Total -----	1,945,801	2,291,486

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

¹ Excludes kaolin.

² Includes electrical porcelain (1975), fertilizers (1976), flower pots (1976), pottery (1976), roofing granules, terra cotta, waterproofing and sealing (1975), and data indicated by symbol W.

Graphite.—Two companies in Elk County and one company in Northampton County produced synthetic graphite. Principal uses for the synthetic graphite were anodes, graphite shapes, crucibles and vessels, and electric motor brushes. Compared with that of 1975, production was 18% less, but value was 39% more.

Gypsum.—One company in Philadelphia County calcined gypsum. Output decreased 9%, but value increased 38.6% compared with 1975 levels. Calcined gypsum was used mainly for prefabricated products such as regular wallboard, type X wallboard, and lath.

Iodine.—The Whitmoyer Laboratories Inc., Lebanon County, and the West Agro Chemical Inc., Washington County, consumed crude iodine in the manufacture of calcium iodate, hydriodic acid, ethylenediamene dihydroiodide, and iodofors, which are used in pharmaceuticals, catalysts, stabilizers, and for sanitation.

Lime.—Ten plants operated by eight companies in eight counties produced 2,069,033 tons valued at \$68.4 million, 7% greater in quantity and 14% greater in value than in 1975. Nearly 84% of the total lime produced and 83% of the total value was attributed to the production of quicklime; hydrated lime accounted for the remainder.

Centre County, with three plants, was the leading producer in the State, with 31% of the total production and 28% of the total value. Other producers are as follows, in alphabetical order: Adams, Butler, Chester, Lebanon, Mifflin, Montgomery, and York Counties.

Nearly 62% of the total lime sold or used by producers was for the steel industry, with lesser amounts used for water purification, sewage treatment, agriculture, and other purposes.

Table 9.—Pennsylvania: Lime sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Steel, BOF	982	29,900	1,034	32,937
Water purification	205	6,228	258	9,043
Steel, electric	124	3,762	151	4,662
Sewage treatment	101	3,081	94	3,092
Steel, open-hearth	66	1,999	93	2,983
Agriculture	50	1,704	66	2,181
Mason's lime	86	2,227	64	1,778
Acid mine water	36	1,096	27	966
Paper and pulp	23	714	24	729
Finishing lime	24	630	W	W
Tanning	6	192	7	262
Other uses ¹	237	8,514	252	9,724
Total ²	1,940	60,047	2,069	68,356

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

¹ Includes refractory dolomite, other chemical uses, explosives, petroleum refining, sand-lime brick, insecticides, sugar refining, other ore concentration, silica brick, wire drawing, soil stabilization (1976), other metallurgy, paint, alkalis, magnesite (1975), and uses indicated by symbol W.

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

Dravo Corp. signed a 15-year contract valued at \$85 million to provide lime to help clean smokestack gases of a coal-fired Allegheny Power System Inc. generating plant to be built near Sistersville, W. Va. Dravo announced a 20-year contract valued at about \$200 million to supply 300,000 to 375,000 tons of lime each year to a new powerplant in Shippingport. The plant is owned by the Central Area Power Coordinating Group of utilities, which includes Cleveland Electric Illuminating Co., Duquesne Light Co., Ohio Edison Co., Pennsylvania Power Co., and Toledo Edison Co. Recently, Dravo signed a third long-term contract with Columbus and Southern Ohio Electric Co. for lime deliveries over a 15-year period.

Mica.—Scrap and flake mica was produced by one company in Adams County. Compared with 1975 levels, production of mica decreased 16%, but increased 2% in value. Mica is used in vacuum-tube capacitors and various electrical and nonelectrical items.

Mullite.—One company produced high-temperature sintered mullite in Philadelphia County. Compared with 1975 levels, quantity and value decreased 53% and 22% respectively. Mullite is a heat-resistant silicate of aluminum used in furnace linings.

Perlite.—Crude perlite was shipped into the State and expanded at five plants by four companies in five counties. A sixth plant located at New Eagle, Washington

County, was scheduled to be in production in January 1977. Production in 1976 totaled 33,085 short tons, with an average value per ton of \$81.74 compared with 33,693 short tons valued at \$78.55 per short ton in 1975. The product was used principally for plaster, horticulture, and cement aggregates. Minor uses were for filter aid, low-temperature insulation, fillers, foundry uses, insulating board, formed products, castable insulation, and bonding mortars.

Sand and Gravel.—The total output of sand and gravel increased 9.4% from 17.4 million tons in 1975 to 19 million tons in 1976. Average value per ton for construction sand and gravel was \$2.66 and for industrial sand and gravel, \$7.30. Construction sand and gravel was used mainly for concrete aggregate and concrete products. Lesser uses were for asphaltic concrete aggregates and other bituminous mixtures, roadbase and coverings, and other uses. Of the 17,975 tons of construction sand and gravel used, 64% of the processed and 1% of the unprocessed sand and gravel was used for commercial purposes; 30% of the processed and 1% of the unprocessed sand and gravel was used for government projects. Ninety-four percent of the industrial sand and gravel was unground sand used mainly for glass manufacturing, fire or furnace, engine, molding, blasting, and other purposes. The remaining 6% of the industrial sand and gravel was ground and used for foundry, porcelain and tile, abrasives, enamel, and other uses.

The number of sand and gravel operations producing less than 25,000 tons totaled 27, and those producing less than 100,000 tons totaled 71, which was 53% of the total number of sand and gravel operations in the State. Only one operation produced in excess of 1 million tons.

Sand and gravel was produced in 40 of the State's 67 counties. Bucks County led with 18% of the State's total. Other leading counties, in descending order of production, were Armstrong, Erie, Beaver, and Lawrence.

Table 10.—Pennsylvania: Sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value
Construction:				
Processed:				
Sand -----	8,495	21,111	9,669	24,886
Gravel -----	6,947	17,771	8,307	22,971
Unprocessed: Sand and gravel -----	954	810		
Industrial sand -----	1,005	7,120	1,063	7,757
Total ² -----	17,401	46,813	19,038	55,611

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant of blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

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

Table 11.—Pennsylvania: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	6,410	17,116	7,940	21,366
Concrete products (cement blocks, bricks, pipe, etc.) -----	1,937	5,215	3,267	8,985
Asphaltic concrete aggregates and other bituminous mixtures -----	1,052	2,756	3,109	9,778
Roadbase and coverings -----	898	1,989	1,673	3,494
Fill -----	509	697	1,465	3,539
Other uses -----	487	521	522	745
Total ¹ -----	11,294	28,295	17,975	47,854

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

Table 12.—Pennsylvania: Sand and gravel sold or used, by county
(Thousand short tons and thousand dollars)

County	1975			1976				
	Number of mines	Quantity	Value	Number of companies	Number of mines	Quantity	Value	Number of companies
Allegheny -----	1	W	W	1	1	W	W	1
Armstrong -----	6	1,723	5,746	4	6	1,960	6,639	4
Beaver -----	5	1,178	3,331	4	4	994	3,088	4
Bedford -----	---	---	---	---	1	W	W	1
Berks -----	2	W	515	2	2	W	W	2
Blair -----	1	W	W	1	1	W	W	1
Bradford -----	3	577	W	2	4	W	W	2
Bucks -----	4	2,362	6,160	3	5	3,469	9,113	4
Butler -----	4	319	584	3	4	294	847	3
Cameron -----	---	---	---	---	1	W	W	1
Carbon -----	2	W	W	---	3	W	W	2
Clarion -----	1	W	W	1	---	---	---	---
Columbia -----	2	W	W	1	2	W	W	---
Crawford -----	5	496	1,100	5	6	505	1,228	6
Cumberland -----	2	W	W	2	2	W	W	2
Dauphin -----	1	W	W	1	1	W	W	1
Erie -----	11	1,522	2,902	11	14	1,954	4,024	14
Forest -----	2	W	W	2	2	W	W	2
Franklin -----	2	W	W	1	2	W	W	1
Fulton -----	1	W	W	1	1	W	W	1
Huntingdon -----	1	W	W	1	1	W	W	1
Lackawanna -----	---	---	---	---	1	W	W	1
Lancaster -----	2	W	W	2	2	W	W	2
Lawrence -----	5	644	1,354	5	9	809	2,079	9
Luzerne -----	5	724	2,433	5	5	630	1,549	5
Lycoming -----	2	W	W	1	1	W	W	1
Mercer -----	2	W	W	2	3	298	604	3
Mifflin -----	1	W	W	1	1	W	W	1
Monroe -----	3	192	541	3	5	364	970	5
Northampton -----	3	752	1,755	3	3	680	1,556	3
Northumberland -----	1	207	522	1	1	230	619	1
Pike -----	1	140	403	1	2	W	W	2
Potter -----	1	W	W	1	---	---	---	---
Schuylkill -----	1	71	295	1	1	74	319	1
Somerset -----	1	W	W	1	1	W	W	1
Tioga -----	3	351	420	3	6	307	529	6
Venango -----	7	834	1,329	7	8	587	1,232	7
Warren -----	8	524	1,093	8	11	435	1,027	10
Wayne -----	3	211	583	3	4	242	662	4
Westmoreland -----	1	355	1,433	1	1	W	W	1
Wyoming -----	3	618	1,775	3	2	W	W	2
York -----	3	W	W	2	3	W	W	2
Undistributed -----	---	3,602	14,418	---	---	5,204	19,529	---
Total ¹ -----	112	17,401	48,742	102	133	19,038	55,611	121

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

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

The leading producers of construction and industrial sand and gravel were as follows, in descending order of production: Warner Co., Davison Sand & Gravel Co., Penn Glass Sand, Glacial Sand and Gravel Co., Erie Sand Steamship Co., and Refractory Sand Co., Inc.

Seventy-two percent of sand and gravel was shipped to market by truck, 23% by water, and the remaining 5% by rail or other means, or used at the plant site.

DER plans to ban dredging for sand and gravel on the Upper Allegheny River within a 5-year period. Preservation of the river as a natural, scenic, and recreational

resource was the primary reasons for adopting the Departmental policy.

Stone.—Pennsylvania led in total stone production, crushed stone, crushed sandstone, dimension slate, and crushed miscellaneous stone; ranked second in dimension sandstone, and dimension miscellaneous stone; and third in output of crushed limestone.

Compared with that of 1975, total stone production in Pennsylvania increased 6% from 60.2 million tons to 63.6 million tons. The value also increased 11% from \$150 million to \$165.9 million.

Crushed stone was produced by 139 com-

panies at 230 quarries for roadbase aggregate, roadstone, cement, and other uses. Output of crushed stone increased 6% to 63.5 million tons valued at \$161.2 million. Leading companies were Koppers Co., Bethlehem Steel Corp., and New Enterprise Stone & Lime Co.

Dimension stone was produced by 29 companies at 32 quarries for rough construction, dressed flagging, cut stone, and other uses. Output in 1976 decreased 9% to 65,112 tons valued at \$4.6 million. Leading producers of dimension stone were A. Dalley and Sons, Inc., and Delaware Quarries.

The unit value of all stone increased 12 cents per ton to \$2.61 in 1976. Unit values of other types of crushed and broken stone were limestone, \$2.54; granite, \$2.75; sandstone, \$2.73; traprock, \$2.37; and other

stone, \$2.39 per ton. Unit value of all dimension stone increased \$3.17 per ton to \$71.25 in 1976.

Of the 261 quarries operating in 54 counties, 17 each were in Bucks and Lancaster Counties, 16 in Northampton, 15 in Berks, and 13 in Montgomery. Montgomery County was the leading producer of stone, followed by Lancaster, Bucks, York, Berks, and Northampton.

Stone production by size of operation showed 69 quarries each producing less than 25,000 tons, and only 10 quarries each producing over 900,000 tons were operating in 1976.

During the year, 87% of the crushed and broken stone was shipped to market by truck, 7% by rail, less than 1% by water, 3% by other means, and 2% by unspecified methods.

Table 13.—Pennsylvania: Production of dimension stone,¹ by use

Use	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Irregular-shaped stone -----	18,690	\$353	15,960	\$332
Dressed flagging -----	11,180	462	11,160	542
Cut stone -----	W	W	10,810	387
Roofing -----	5,973	1,039	5,390	934
Structural and sanitary purposes -----	6,066	1,262	4,786	1,191
Rubble -----	2,873	36	2,519	31
Rough flagging -----	2,141	70	1,946	55
Billiard tables -----	1,987	457	1,772	405
Blackboards -----	264	136	193	100
House stone veneer -----	115	3	140	4
Rough blocks -----	3,917	279	—	—
Flooring -----	963	159	W	W
Other uses ² -----	17,060	593	10,430	657
Total ³ -----	71,231	4,849	65,112	4,639

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

¹ Includes sandstone, slate, granite, and miscellaneous stone.

² Includes rough monumental (1976), dressed construction, electrical fixtures, curbing, and uses indicated by symbol W.

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

Table 14.—Pennsylvania: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	16,650	36,390	15,006	34,818
Roadstone -----	8,955	19,450	10,496	24,350
Cement manufacture -----	7,089	13,960	8,345	16,551
Bituminous aggregate -----	5,760	14,410	6,989	18,081
Concrete aggregate -----	6,217	15,189	6,005	15,236
Surface treatment aggregate -----	3,038	6,433	3,700	8,196
Lime manufacture ² -----	3,471	8,665	3,635	10,703
Flux stone -----	2,729	8,772	2,778	9,278
Agricultural limestone -----	1,707	6,948	1,786	8,484
Railroad ballast -----	1,267	3,326	1,306	3,430
Macadam aggregate -----	1,154	2,619	1,114	2,418
Riprap and jetty stone -----	430	1,037	910	2,261
Mine dusting -----	123	995	141	1,415
Building products -----	218	564	95	223
Other filler -----	117	746	92	1,304
Filter stone -----	82	212	78	203
Refractory stone -----	137	1,785	54	623
Acid neutralization -----	28	W	24	W
Asphalt filler -----	56	320	W	W
Other uses ³ -----	875	3,008	986	3,679
Total ⁴ -----	60,106	144,820	63,542	161,250

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

¹ Includes limestone, miscellaneous stone, sandstone, traprock, and granite.

² Includes dead-burned dolomite (1976).

³ Includes mineral food, whiting, glass, fill, abrasives, terrazzo and exposed aggregate, sulfur dioxide, waste material, and uses indicated by symbol W.

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

Table 15.—Pennsylvania: Stone production, by size of operation, in 1976

Size of operation	Total stone			Dimension stone			Crushed and broken stone		
	Number of quarries	Short tons	Percent of total	Number of quarries	Short tons	Percent of total	Number of quarries	Short tons	Percent of total
Less: than 25,000	69	847,325	5	32	65,112	100.0	37	282,213	4
25,000 to 49,999	19	647,825	1.0	--	--	--	19	647,825	1.0
50,000 to 74,999	12	750,503	1.2	--	--	--	12	750,503	1.2
75,000 to 99,999	13	1,156,204	1.8	--	--	--	13	1,156,204	1.8
100,000 to 199,999	41	6,119,924	9.8	--	--	--	41	6,119,924	9.8
200,000 to 299,999	28	6,852,436	10.8	--	--	--	28	6,852,436	10.8
300,000 to 399,999	22	7,694,975	12.1	--	--	--	22	7,694,975	12.1
400,000 to 499,999	26	11,425,847	18.0	--	--	--	26	11,425,847	18.0
500,000 to 599,999	9	4,914,470	7.7	--	--	--	9	4,914,470	7.7
600,000 to 699,999	4	2,576,707	4.0	--	--	--	4	2,576,707	4.0
700,000 to 799,999	2	1,474,578	2.3	--	--	--	2	1,474,578	2.3
800,000 to 899,999	6	5,082,968	7.9	--	--	--	6	5,082,968	7.9
900,000 and over	10	14,613,315	23.0	--	--	--	10	14,613,315	23.0
Total	261	63,607,167	--	32	65,112	--	229	63,542,055	--

Table 16.—Pennsylvania: Stone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976			Kind of stone produced in 1976
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Adams -----	3	W	W	3	W	W	Limestone, traprock.
Allegheny -----	1	80	223	1	W	W	Sandstone.
Armstrong -----	4	160	531	6	589	1,430	Limestone.
Bedford -----	3	W	W	3	W	W	Limestone, sandstone.
Berks -----	14	3,460	7,209	15	4,098	8,633	Limestone, sandstone, traprock.
Blair -----	6	W	W	6	1,382	3,849	Limestone, dolomite, quartzite.
Bucks -----	16	4,227	10,323	17	W	W	Do.
Butler -----	6	W	6,133	8	W	W	Limestone, sandstone.
Carbon -----	3	W	W	2	W	W	Limestone, quartzite.
Centre -----	7	2,546	6,213	8	2,563	6,467	Limestone.
Chester -----	11	3,394	7,776	11	3,577	8,658	Limestone, sandstone, traprock, quartzite.
Clarion -----	3	267	813	3	277	937	Limestone, sandstone.
Clearfield -----	--	--	--	1	102	270	Sandstone.
Clinton -----	1	W	W	1	W	W	Limestone.
Columbia -----	1	W	W	2	W	W	Limestone, sandstone.
Cumberland -----	7	1,264	2,837	7	980	2,514	Do.
Dauphin -----	3	1,074	2,138	3	1,099	2,359	Do.
Delaware -----	3	W	W	3	W	W	Sandstone, traprock.
Elk -----	1	W	1	3	43	187	Sandstone.
Fayette -----	5	W	W	3	W	W	Limestone.
Forest -----	--	--	--	1	1	W	Sandstone.
Franklin -----	3	W	W	3	W	W	Sandstone, limestone.
Fulton -----	2	W	W	2	W	W	Limestone.
Huntingdon -----	7	W	W	7	707	1,660	Limestone, quartzite.
Indiana -----	1	W	167	1	32	W	Sandstone.
Jefferson -----	1	W	W	1	30	77	Do.
Juniata -----	1	179	312	1	97	193	Limestone.
Lackawanna -----	1	W	W	2	W	W	Sandstone.
Lancaster -----	17	3,932	10,236	17	4,560	12,257	Limestone, dolomite, other.
Lawrence -----	4	1,090	3,199	4	1,310	3,256	Limestone.
Lebanon -----	3	2,725	6,949	3	2,898	7,754	Do.
Lehigh -----	9	2,091	W	9	2,146	4,409	Limestone, slate.
Luzerne -----	5	1,105	2,840	5	868	2,095	Sandstone.
Lycoming -----	2	W	W	2	W	W	Limestone.
McKean -----	3	W	W	5	38	138	Sandstone.
Mercer -----	1	W	W	1	W	W	Do.
Mifflin -----	5	324	745	4	225	577	Limestone.
Monroe -----	3	830	2,183	3	653	1,753	Limestone, sandstone, other.
Montgomery -----	13	4,910	12,092	13	5,039	12,964	Limestone, dolomite, sandstone, granite.
Montour -----	3	W	W	3	W	W	Limestone.
Northampton -----	18	3,724	8,984	16	3,849	9,208	Limestone, quartzite, slate.
Northumberland -----	3	W	W	3	502	1,165	Limestone, sandstone.
Perry -----	1	W	W	1	W	W	Limestone.
Pike -----	1	W	W	1	W	W	Traprock.
Potter -----	2	W	W	2	W	W	Sandstone.
Schuylkill -----	3	W	W	3	668	1,484	Limestone, sandstone, quartzite.
Snyder -----	1	W	W	2	W	W	Limestone.
Somerset -----	6	W	W	6	688	2,534	Limestone, sandstone.
Susquehanna -----	5	117	472	8	W	W	Sandstone.
Tioga -----	1	237	431	3	152	303	Do.
Union -----	3	W	W	2	W	W	Limestone.
Wayne -----	2	280	602	4	W	W	Sandstone, other.
Westmoreland -----	8	2,033	6,028	8	2,615	7,176	Limestone, sandstone.
York -----	10	W	W	9	4,209	13,543	Do.
Undistributed -----	--	20,128	50,228	--	17,610	48,039	
Total -----	246	60,177	149,670	261	63,607	165,889	

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

Sulfur.—Three petroleum refineries operated by three companies in Delaware and Philadelphia Counties plus one steel company in Allegheny County produced 90,551 long tons of sulfur and sold or used 91,257 long tons. Compared with 1975 levels, sulfur sold or used increased 34% in output and 52% in value. Stocks of sulfur decreased from 1,338 long tons on January 1 to 633 long tons at yearend.

Tripoli.—Crude tripoli was mined by Keystone Filler and Manufacturing Co., Lycoming County. Compared with 1975 levels, the tonnage sold or used and value increased 93% and 114%, respectively. Tripoli is used mainly for abrasive purposes.

Vermiculite (Exfoliated).—Crude vermiculite shipped into the State was exfoliated by three companies, one in each of three counties. The total quantity and value sold or used by producers was greater compared with 1975 levels. Major uses in the building industry were for lightweight concrete aggregate, loose fill insulation, and other purposes.

METALS

Cadmium.—Pennsylvania ranked fourth in smelter production of cadmium behind Colorado, Illinois, and Idaho, but first in value. Production of cadmium in the State increased 264% in quantity and 301% in value. Cadmium, which is produced from smelting zinc ores, is used for electroplating parts of appliances, motor vehicles, and machinery.

Copper.—Pennsylvania had a minimal production of copper during the year. Copper was obtained as a byproduct from processing other mined minerals.

Iron Ore.—Bethlehem Mines Corp. produced iron ore at its Grace underground mine in Berks County. Production was 1% less than in 1975. All concentrates were pelletized prior to shipment to Bethlehem's steelmaking facilities.

Iron Oxide Pigments.—Production was in five counties by six companies. United States Steel produced iron oxide from steel plant dust in Allegheny County. Both Pfizer, Inc., and Reichard-Coulston Inc., Northampton County, produced natural and synthetic pigments. Other counties in which production occurred included Carbon, Chester, and Montgomery. Production totaled 46,584 short tons valued at \$17.4 million compared with 39,540 short

tons valued at \$13.9 million in 1975. Iron oxide pigments were used in paints, rubber, plastics, concrete products, paper, magnetic ink, fertilizers, and animal food.

Iron and Steel.—Shipments of pig iron in Pennsylvania in 1976 totaled 17.98 million tons valued at \$3,159,081,988, an increase of 4% in total shipments and nearly 9% in value compared with that of 1975. At the beginning of 1976, 25 blast furnaces were operating and 25 were idle for a total of 50 furnaces, compared with 34 operating furnaces and 16 idle the year earlier. Types of pig iron produced were basic, bessemer, malleable, and direct castings, having an average value per ton of from \$74.38 to \$94.03.

In early September, steel firms announced layoffs due to a current business downturn. J&L closed one blast furnace at its Aliquippa plant and one open-hearth furnace at its Pittsburgh works. U.S. Steel's Fairless Hill works reported two of eight furnaces in the open hearth were idled, with production curtailments occurring in the rolling mills and processing lines. Other Pittsburgh-based steel firms also reported curtailment of steelmaking operations outside of the Pennsylvania area.

Early in the year, the U.S. Department of Labor announced that nearly 1,300 specialty steel workers at five Pittsburgh area plants were eligible for special compensation because of jobs lost as a result of foreign competition. Covered by the Labor Department's ruling are an estimated 500 workers of the Universal-Cyclops Specialty Steel Division, Bridgeville plant; 300 at the Pittsburgh plant; 300 at the Titusville plant; and 20 at the Aliquippa plant. In addition, up to 150 former employees at Teledyne-Vasco's tool steel plant at Latrobe would be affected by the ruling. Jobless steel workers could receive 70% of last year's \$176-per-week average wages for up to 52 weeks.

Phoenix Steel Corp., a specialty steelmaker controlled by the French company, CREUSOT-LOIRE, S.A., announced in early November closing of the structurals division in Phoenixville, affecting 672 employees. The company's seamless pipe and tubing products division was not affected by the layoffs.

J&L, a unit of LTV Corp., ordered components for a new electric furnace steelmaking facility at its Pittsburgh works. Other modernization plans included con-

struction of a 2-furnace basic oxygen shop to replace the plant's 11 open-hearth furnaces and pollution control equipment improvements. Duquesne Light Co. will supply J&L's electric furnace with up to 200,000 kilowatt-hours, increasing Duquesne Lights total output by 7% or 8%. To meet this new electric demand, Duquesne Light will expand an electric substation and install miles of underground high-voltage transmission cable.

Universal Cyclops will install at its Bridgeville plant a 50-ton argon-oxygen decarburization (AOD) furnace along with an advanced environmental control system to serve both electric furnace melting and the new AOD refining operations. Completion was scheduled for early 1978.

U.S. Steel decided to build a \$3 billion steel plant on the Pennsylvania-Ohio line near Lake Erie. Environmental studies of the area were underway at yearend.

Table 17.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives: Satellite Alloy Corp.	9800 McKnight Rd. Pittsburgh, Pa. 15237	Plant -----	Allegheny.
Cement:			
Amcord, Inc. ¹ -----	610 Newport Center Dr. Newport Beach, Calif. 92660	----do -----	Northampton.
Coplay Cement Manufacturing Co. ¹ -----	Nazareth, Pa. 18064 -----	----do -----	Lehigh and Northampton.
Keystone Portland Cement Co. ¹ -----	Box 1785 Allentown, Pa. 18105	----do -----	Northampton.
Louisville Cement Co -----	501 South 2d St. Louisville, Ky. 40202	----do -----	Lawrence.
Medusa Corp. ^{1,2} -----	Box 5668 Cleveland, Ohio 44101	----do -----	Lawrence and York.
Penn-Dixie Industries, Inc. ^{1,2} -----	60 East 42d St. New York, N.Y. 10017	----do -----	Butler and Northampton.
United States Steel Corp. ^{1,3} -----	600 Grant St. Pittsburgh, Pa. 15230	----do -----	Allegheny and Northampton.
Clays:			
Dresser Industries, Inc -----	Box 6504 Houston, Tex. 77005	Pit -----	Clearfield and Somerset.
Glen-Gery Corp -----	227 North 5th St. Reading, Pa. 19601	Pit -----	Adams, Berks, Northumberland, Union, York.
Hanley Co -----	28 Kennedy St. Bradford, Pa. 16701	Pit -----	Jefferson and McKean.
Resco Products -----	Box 108 Morristown, Pa. 19404	Pit -----	Clearfield and Huntingdon.
Coal, anthracite:			
Greenwood Stripping Corp.	1 Venice St. Nesquehoning, Pa. 18240	Strip mine -----	Carbon and Schuylkill.
Jeddo-Highland Coal Co ---	800 Exeter Ave. West Pittston, Pa. 18643	Strip mine and culm bank.	Luzerne.
Leon E. Kocher Coal Co ---	Box 127 Valley View, Pa. 17983	Underground mine.	Schuylkill.
Reading Anthracite Co ---	200 Mahantongo St. Pottsville, Pa. 17901	Culm bank and strip mine.	Northumberland and Schuylkill.
Coal, bituminous:			
Barnes & Tucker Co -----	357 Lancaster Ave. Haverford, Pa. 19041	Underground mine.	Cambria.
Bethlehem Mines Corp. ^{4,5} ---	701 East 3d St. Bethlehem, Pa. 18016	----do -----	Cambria and Washington.
C&K Coal Co -----	Box 69 Clarion, Pa. 16214	----do -----	Greene.
Pittsburg & Midway Coal Co.	10 Main Center Kansas City, Mo. 64105	----do -----	Washington.
Graphite, synthetic:			
Air Reduction Co., Inc -----	Theresa St. St. Marys, Pa. 15857	Plant -----	Elk.
Charles Pfizer & Co., Inc. ⁵ ---	235 East 42d St. New York, N.Y. 10017	----do -----	Northampton.
Stackpole Carbon Co -----	St. Marys, Pa. 15857 -----	----do -----	Elk.
Gypsum, calcined: United States Gypsum Co. ⁶	101 South Wacker Dr. Chicago, Ill. 60606	----do -----	Philadelphia.

See footnotes at end of table.

Table 17.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Iron oxide pigments:			
The Prince Manufacturing Co.	Bowmanstown, Pa. 18030	Plant	Carbon.
Reichard-Coulston, Inc.	15 East 26th St. New York, N.Y. 10010	do	Northampton.
Lime:			
The J. E. Baker Co. ¹	Box 1189 York, Pa. 17405	do	York.
Mercer Lime & Stone Co.	1640 Oliver Bldg. Pittsburgh, Pa. 15222	do	Butler.
National Gypsum Co. ^{1,2,7}	325 Delaware Ave. Buffalo, N.Y. 14202	do	Centre.
Peat:			
Lake Benton Peat Moss	1418 North Main St. Scranton, Pa. 18508	Bog	Lackawanna.
Perlite, expanded:			
Armstrong Cork Co.	Lancaster, Pa. 17603	Plant	Lancaster.
Atlantic Perlite	Box 345 Primrose, Pa. 19018	do	Delaware.
Pennsylvania Perlite Corp.	Box 2002 Lehigh Valley, Pa. 18001	do	Lehigh and York.
Perlite Manufacturing Co.	Box 478 Carnegie, Pa. 15106	do	Allegheny.
Petroleum refineries:⁸			
Sand and gravel:			
Davison Sand & Gravel Co.	34th Ave. and 4th St. New Kensington, Pa. 15068	Dredge	Westmoreland.
Dravo Corp.	One Oliver Plaza Pittsburgh, Pa. 15222	do	Beaver.
Erie Sand Steamship Co.	Erie, Pa. 16500	do	Erie.
Shippingport Sand & Gravel Co.	1200 Slambaugh Bldg. Youngstown, Ohio 44501	Pit	Armstrong.
Warner Co. ^{1,4}	1721 Arch St. Philadelphia, Pa. 19103	Pit	Bucks.
Stone:			
G. & W. H. Corson, Inc. ⁴	Plymouth Meeting, Pa. 19462	Quarry	Montgomery.
The General Crushed Stone Co.	712 Drake Bldg. Easton, Pa. 18042	do	Bucks, Chester, Lancaster, Luzerne, Perry.
Glasgow Quarry, Inc.	Route 2, Box 121 Glasgow, Mo. 65254	do	Montgomery.
Martin-Marietta Corp.	11300 Rockville Pike Rockville, Md. 20852	do	Centre, Chester, Fayette, Northampton.
New Enterprise Stone & Lime.	New Enterprise, Pa. 16664	do	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.
Sun Oil Co.	1608 Walnut St. Philadelphia, Pa. 19103	do	Delaware.
Tripoli:			
Keystone Filler & Manufacturing Co.	Muncy, Pa. 17756	Pit	Lycoming.
Vermiculite, exfoliated:			
Hyzer & Lewellen	Box 155 Southampton, Pa. 18966	Plant	Bucks.
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	do	Lawrence.

¹ Also stone.² Also clays.³ Also coal.⁴ Also lime.⁵ Also iron ore.⁶ Also expanded perlite.⁷ Also cement.⁸ Many major oil companies operate refineries in Pennsylvania and several commercial directories contain lists of them.

The Mineral Industry of Puerto Rico, The Virgin Islands, and Pacific Island Possessions

The Puerto Rico section of this chapter has been prepared through cooperation between the Bureau of Mines and the Geological Survey, U.S. Department of the Interior.

By John W. Sweeney¹ and Charlie Wyche²

PUERTO RICO³

Unemployment in Puerto Rico reached a record 18% reflecting the continued recession on the island. The construction industry was the hardest hit segment with employment reaching its lowest level since 1970. Puerto Rico's mineral production, virtually all construction materials, is directly related to construction and business activity on the island.

The Secretary of Natural Resources, under authority of Article XIX, Law No. 144, June 3, 1976, adopted bylaws to reg-

ulate granting of permits for extraction, removal, and dredging of sand and gravel, stone, earth, silica, calcite, clays, and any other similar component of the earth's crust that is not regulated as an economic mineral, on public and private lands, within the geographical boundaries of the Commonwealth of Puerto Rico.

¹ State Liaison Officer (Florida and Puerto Rico), Bureau of Mines, Tallahassee, Fla.

² Physical scientist, International Data and Analysis.

³ Prepared by John W. Sweeney.

Table 1.—Mineral production in Puerto Rico¹
(Thousand short tons and thousand dollars)

Mineral	1975		1976	
	Quantity	Value	Quantity	Value
Cement, portland -----	1,582	60,968	1,558	66,150
Clays -----	341	440	W	W
Lime -----	28	2,231	28	2,513
Salt -----	27	639	27	639
Stone -----	13,595	47,515	13,404	47,124
Total -----	XX	111,793	XX	² 116,426
Total 1967 constant dollars -----	XX	44,236	XX	^p 41,855

^p Preliminary. 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 Total of listed items only; excludes value of common clay, which has been withheld to avoid disclosing company proprietary data.

Table 2.—Value of mineral production in Puerto Rico, by district¹
(Thousands)

Senatorial district	1975	1976	Minerals produced in 1976 in order of value
Aguadilla -----	\$624	W	Stone.
Arecibo -----	193	\$37	Do.
Guayama -----	127	--	
Humacao -----	66	W	Do.
Mayaguez -----	3,798	2,957	Stone, salt.
Ponce -----	27,244	W	Cement, lime, stone, clays.
San Juan -----	43,873	W	Cement, stone, clays.
Undistributed ² -----	35,868	113,433	
Total -----	111,793 ³	116,426	

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

¹ Sand and gravel production values are not available.

² Includes stone that cannot be assigned to specific districts and values indicated by symbol W.

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

A Federal three-judge panel ordered that a suit questioning the constitutionality of the 1933 Puerto Rican mines law be turned over to the Commonwealth Supreme Court for disposition. The 1902 Puerto Rico Civil Code states that the owner of the land also owns the subsurface; the 1933 mines law transfers ownership of the subsurface to the Commonwealth without any compensation to the landowners.

The Puerto Rican Water Resource Authority (WRA), due to economic considerations, has decided not to construct the \$600 million 600-megawatt nuclear plant at Arecibo. The contracted for components of the plant have been put up for sale.

The Puerto Rico Nuclear Center was transformed into a new energy research center under a long-term agreement between the Federal Energy Research and Development Administration (ERDA) and the University of Puerto Rico. The new \$12 million center will be known as the Center of Energy and Environmental Research and will carry out research to develop new sources of power, such as solar and geothermal.

Puerto Rico and Venezuela agreed to sponsor a preliminary study on the feasibility of constructing a steel plant in Puerto Rico. The agreement was under the joint sponsorship of Fomento and the Commonwealth planning board (Puerto Rico) and Consejo Siderúrgico Nacional de Venezuela, Corporación Venezolana de Guayana, and Siderúrgica del Orinoco S.A. The two Governments also agreed to sponsor a complementary study of the

Puerto Rican and Venezuelan petrochemical industries.

A final feasibility study to determine if Puerto Rico's copper deposits will be mined was scheduled to begin. The study will be made by AMAX, Inc., and the Kennecott Copper Corp. at a cost of about \$5 million. It will take 12 to 18 months to complete. The two companies, which have been negotiating with the Government for more than 10 years, feel that they must reexamine the project in the light of increased costs and the drastic reduction in the world price of copper.

The Government and the mining companies have a preliminary agreement that would give each of the three participants a 33.3% interest during the first 10 years of operation while the companies are recovering their initial investment. After the 10th year of operation, the Commonwealth could buy up to 51% of the total stock, leaving each of the companies with 24.5%. The companies also have agreed in principle to try to process the copper in Puerto Rico, although the extent to which the processing phase will take place will depend on the new feasibility study. There was no commitment, however, on the part of the companies to build satellite plants which the Government hopes to attract to Puerto Rico when the mining operation begins.

The most important point on which there is still no agreement is that of tax exemption. The Government still feels that the mining operation as such should receive no tax exemption, but the manufacturing stage should be exempt. The copper

companies are proposing a 50% tax exemption for the entire operation, which is expected to last 30 years.

The Commonwealth Government and Universal Oil Products Co. (UOP) continued negotiations to develop the Guanajibo nickel laterites near Mayaguez. UOP conducted bench-scale tests on the laterites at its Tucson, Ariz., facility to develop additional recovery data. The company would like to receive Government guarantees for operations before undertaking a full feasibility study.

During the year, St. Joe Minerals Corp. conducted a limited geochemical survey in the central area of the island. The survey indicated several weak gold anomalies, but final results have not been released.

A private group also performed geochemical exploration for gold in the Patillas area. Primary results were encouraging and additional prospecting may proceed upon receiving a Government prospecting permit.

The Secretary of Natural Resources invited 50 firms to negotiate for oil and natural gas exploration rights on the ocean floor off the north coast of the island, between San Juan and Manati. Geological studies conducted thus far have indicated that there may be petroleum in the area. The exploration could cover a 40-mile area west of San Juan to just east of Manati in waters that range from several hundred feet to 3,000 feet in depth. Early exploration is anticipated to be in waters of 200 to 300 feet deep about 2 miles offshore. The Natural Resources Development Corporation, a Government agency, will be given the exclusive right to perform the exploratory drilling and to eventually develop whatever deposits are found.

Legislation and Government Programs.—The Caribbean District of the Water Resources Division of the U.S. Geological Survey published five Water Resources Investigation Reports.⁴

Also issued were two annual basic data reports⁵ and eight open-file reports.⁶

Surface-water, ground-water, water-quality, and sediment data-collection networks were continued. Hydrologic studies were continuing in St. Croix, U.S. Virgin Islands, and in the north coast limestone area of Puerto Rico, on the Fort Allen ground-water recharge investigation, and on a floods investigation program. A re-

gional ground-water assessment and a ground-water management plan for selected areas in Puerto Rico were begun.

REVIEW BY MINERAL COMMODITIES

Cement.—The Catano plant of Puerto Rican Cement Co., Inc., shut down June 30 because of a 27% decrease in demand for its products since 1973. Approximately 225 workers were dismissed. The company

⁴ Anderson, H. R. Ground Water in the San Juan Metropolitan Area, Puerto Rico. U.S. Geol. Survey Water Res. Inv. Rept., 41-75, 1976, 34 pp.

Ellis, S. R. History of Dredging and Filling of Lagoons in the San Juan Area, Puerto Rico. U.S. Geol. Survey Water Res. Inv. Rept. 3-76, 1976, 25 pp.

Ellis, S. R., and Gomez-Gomez. Hydrologic Characteristics of Lagoons at San Juan, Puerto Rico, During a January 1974 Tidal Cycle. U.S. Geol. Survey Water Res. Inv. Rept., 38-75, 1976, 45 pp.

Giusti, E. V., and C. D. Bennett. Water Resources of the North Coast Limestone Area, Puerto Rico. U.S. Geol. Survey Water Res. Inv. Rept., 42-75, 1976, 42 pp.

Jordan, D. G., and B. K. Gilbert. Water Supply and Waste Disposal, Culebra, Puerto Rico. U.S. Geol. Survey Water Res. Inv. Rept., 3-76, 1976, 31 pp.

⁵ U.S. Geological Survey. 1973 Water Resources Data for Puerto Rico. Part 1, Surface Water Records. Water Res. Data Rept., 1976, 69 pp.

_____. 1974 Water Resources Data for Puerto Rico. Part 2, Water-Quality Records. Water Res. Data Rept., 1976, 158 pp.

⁶ Bennett, G. D. Electrical Analog Simulation of the Aquifers Along the South Coast of Puerto Rico. U.S. Geol. Survey Open-File Rept., PR-76-4, 1976, 101 pp.

Colon-Diappa, E., and L. J. Mansue. Water Resources of the Proposed Copper Mining Area, Puerto Rico; 1958-74. U.S. Geol. Survey Open-File Rept., PR-76-1, 2 parts, 1976, 414 pp.

Ellis, S. R., and F. Gomez-Gomez. Water Quality and Hydraulic Data, San Juan Lagoon System, Puerto Rico. U.S. Geol. Survey Open-File Rept., PR-75-2, 1975, 142 pp.

Heisel, J. E., and J. R. Gonzalez. Ground-Water Levels on the South Coast of Puerto Rico, February 1976. U.S. Geol. Survey Open-File Rept., PR-76-705, 1976, 13 pp.

Quinones-Marquez, F. Chemical, Physical, Biochemical, and Bacteriological Determinations in Lago Loiza, Puerto Rico and in its Main Tributaries, September 1973-December 1974. U.S. Geol. Survey Open-File Rept., PR-76-7, 1976, 74 pp.

_____. Chemical, Physical, Biochemical, and Bacteriological Determinations in Laguna Tortuguero, Puerto Rico, July 1974-June 1975. U.S. Geol. Survey Open-File Rept., PR-76-5, 1976, 39 pp.

Quinones-Marquez, F., P. Vazquez, A. Class, J. Latkovich. Water Records of the Rio Piedras Basin, Puerto Rico, 1971-1974. U.S. Geol. Survey Open-File Rept., PR-76-3, 1976, 111 pp.

Quinones-Marquez, F., P. Vazquez, A. Class, and R. Pena-Cortes. Chemical, Physical, Biochemical, and Bacteriological Characteristics at Selected Stream Sites in Puerto Rico, 1974-75. U.S. Geol. Survey Open-File Rept., PR-76-1, 1976, 163 pp.

will continue to operate its main Ponce plant, which is currently producing at 70% of its 10,000-bag-per-day capacity. The firm expects to be able to supply the island's cement demand from its Ponce plant.⁷

The Puerto Rican Cement Co. in 1974 was granted a price increase and a Puerto Rico Government loan of about \$15 million to help finance an air control program now underway at the Cantano and Ponce plants. MacDonald Engineering is performing design engineering for both locations. At the Ponce plant, a new 3,000-ton-per-day crushing plant, designed by MacDonald, with equipment supplied by Hammermills, Inc., was scheduled for construction in 1976.⁸

San Juan Cement Co., Inc., installed \$500,000 worth of dust control equipment.⁹

Puerto Rican Cement Co. announced that negotiations had been completed to export at least 10,000 tons of bulk cement per month to Venezuela. Venezuela has experienced a severe shortage of cement due to an increase in construction activity. Since local production proved insufficient to meet demand, consumers requested and obtained permits from the Venezuelan Government to import cement from Puerto Rico and other cement-producing areas during this shortage period.¹⁰

According to the Puerto Rican Cement Co.'s Annual Report for 1976, sales in 1976 were valued at \$55.8 million compared with \$55.6 million during 1975. Sales during the fourth quarter of 1976 were affected by a slowdown in the construction industry in the weeks preceding the election and once again by heavy rains in October. Local cement sales amounted to 20,235,077 bags or 67% of the total island consumption. This compared with sales of 20,186,000 bags in 1975 or 65% of the local market.

Export sales in 1976 totaled 2,507,975 bags compared with 2,378,000 bags in

1975, which reflected the continued low demand for cement in the traditional Caribbean markets due to depressed economic conditions.

Production of gray cement during the year was 22,597,864 bags compared with 22,451,433 bags in 1975. Annual capacity of the company, operating three of six kilns, was approximately 24,000,000 bags. However, the company could expand its production capacity to 30,000,000 if the demand warranted it.

Clays.—Puerto Rican Cement Co. Inc., and San Juan Cement Co., Inc., produced common clay for use in cement manufacture. Output declined 2% and value 6% from that of 1975. This decline was directly attributable to the decline in cement output.

Graphite.—Union Carbide produced synthetic graphite at its Puerto Rican plant for the manufacture of electrodes.

Lime.—Puerto Rican Cement Co., Inc., produced chemical lime at Ponce for water purification, sugar refining, S-type mason's lime for construction and plastering in tropical climates, and other uses. Output was 28,381 tons, a slight increase over that of 1975. The lime was consumed in Puerto Rico and the Virgin Islands.

Salt.—Sal de Borinquen, Ponce Salt Industries, and Guanica produced salt from sea water by solar evaporation near Mayaguez. Production was at the same level as in 1975.

Sand and Gravel.—According to the Puerto Rican Department of Natural Resources, sand and gravel production in 1976 was 13,767,487 short tons valued at \$19,454,000.

Stone.—Limestone, marble, traprock, granite, and sandstone were produced in

⁷ San Juan Star. Mar. 4, 1976.

⁸ Pit and Quarry. V. 68, No. 7, January 1976, p. 65.

⁹ Rock Products. V. 79, No. 1, January 1976.

¹⁰ Rock Products. V. 79, No. 4, April 1976.

Table 3.—Puerto Rico: Portland cement salient statistics

	1975	1976
Number of active plants -----		3
Production -----short tons--	1,581,846	1,545,318
Shipments from mills:		
Quantity -----do-----	1,581,577	1,557,982
Value -----	\$60,968,224	\$66,150,305
Stocks at mills, Dec. 31 -----short tons--	43,355	31,108

Table 4.—Puerto Rico: Production of crushed stone¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Roadstone	8,361	35,700	8,136	35,340
Cement manufacture	W	W	3,066	4,737
Concrete aggregate	1,454	3,766	1,396	3,781
Bituminous aggregate	180	476	277	801
Dense-graded roadbase stone	346	736	254	563
Terrazzo and exposed aggregate	51	264	30	152
Lime manufacture	W	W	29	48
Macadam aggregate	15	67	W	W
Surface treatment aggregate	34	70	W	W
Soil conditioners	--	--	W	20
Other fillers or extenders	1	2	W	W
Other uses ²	3,011	5,527	60	163
Total³	13,453	46,608	13,248	45,605

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

¹ Includes limestone, traprock, marble, granite, and miscellaneous stone (1975).

² Includes stone used for asphalt filler, riprap and jetty stone, and mineral food (1975).

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

Puerto Rico in 1976. Total stone production declined 1% in both quantity and value, reflecting the continuing recession in Puerto Rico.

Four companies produced dimension stone for rough construction and rough blocks. Output increased 11% to 157,200 tons valued at \$1,515,000.

Crushed stone was produced by 23 companies. Output decreased about 1% to 13,250,000 tons valued at \$45.6 million.

Total crushed stone distribution was for cement manufacture, roadstone, concrete, and other uses. Virtually all was transported by truck.

Sulfur.—Elemental sulfur was recovered as a byproduct by Puerto Rico Sun Oil Co. and by the Commonwealth Oil Refining Co., Inc., at its refineries. (The value of byproduct sulfur is not included in table 1.)

VIRGIN ISLANDS¹¹

The U.S. Virgin Islands are about 40 miles east of Puerto Rico. They consist of about 50 islands and cays and are a part of the Antilles, which form the border between the Caribbean Sea and the Atlantic Ocean. The three main islands, St. Croix, St. Thomas, and St. John, contain an estimated 100,000 inhabitants and dominate the commercial activity of the group.

Mineral production consists chiefly of basalt (traprock), which is crushed for use in concrete aggregate and roadstone. Caribbean Materials Supply Company and St. Croix Stone and Sand Company accounted for the total production. Output

and value increased substantially over 1975 levels.

The Hess Oil Virgin Islands Corp. continued operation of its refinery and recovered elemental sulfur in the process.

The U.S. Army Corps of Engineers issued a permit to the Virgin Islands Refinery Corp. for construction of a 3,000-foot deepwater port off the south coast of St. Croix. The permit is the first to be issued for a deepwater superport, which will accommodate 100-foot draft supertankers on the Atlantic coast.¹²

¹¹ Prepared by John W. Sweeney.

¹² Sarasota Herald-Tribune. June 19, 1976.

Table 5.—Production of stone in the Virgin Islands ¹
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1975	253	1,813
1976	279	2,050

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

PACIFIC ISLAND POSSESSIONS ¹³

American Samoa.—American Samoa consists of seven islands in the South Pacific. The principal island is Tutuila, which contains 80% of the total population. Virtually all of American Samoa's mineral output, which consisted of volcanic cinder and limestone, was on Tutuila Island. Production of volcanic cinder in 1976 was about three times the 1975 total, but limestone output declined 13%.

The Department of Public Works operated the quarries, which supplied limestone for concrete and asphalt plants. This material was used domestically for new access roads to three villages in northern Tutuila.

Guam.—Guam, the largest of the Mariana Islands, is located in the Western Pacific at the southernmost end of the island chain. It covers about 210 square miles and has an estimated population of 100,000. Domestic growth and economic activities have remained more or less static since 1974 because of the worldwide economic recession. Total output of crushed limestone, mined mainly for aggregate and roadstone, declined from that of 1975. Hawaiian Rock Products Co., Perez Bros. Inc., Pacific Rock Corp., and the Department of Public Works, Guam Government, produced the limestone.

Table 6.—Mineral production in the Pacific Island Possessions ¹

Area and mineral	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
American Samoa:				
Volcanic cinder	15,000	\$15,000	47,000	\$30,000
Limestone	34,375	147,000	30,000	156,000
Total	XX	162,000	XX	186,000
Guam: Limestone	780,904	1,837,000	457,000	1,438,000

XX Not applicable.

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

TRUST TERRITORY OF THE PACIFIC ISLANDS ¹⁴

This Territory, commonly called Micronesia, comprises about 2,000 islands in the Mariana, Marshall, and Caroline groups. Approximately 120,000 people live on the islands, which lie between Hawaii and the Philippines and were administrated by a High Commissioner appointed by the President of the United States. However, in March 1976, a covenant between the

United States and the representatives of the people of the Northern Mariana Islands was enacted, which will establish a commonwealth of the Northern Mariana Islands by 1981.

The only mineral produced in Micronesia was volcanic rock for aggregate used

¹³ Prepared by Charlie Wyche.

¹⁴ Prepared by Charlie Wyche.

in concrete. Small reserves of phosphate exist in the three island groups but were not considered significant enough to warrant mining. Reserves of bauxite ore, sufficient to yield a total of about 5 million short tons of washed ore containing 50% alumina, were on Bablethuap in the Palau Islands.

A consortium of United States, Japanese, and Iranian interests was considering the Palau Islands as the site for a multi-million-dollar oil storage, refining, and transshipment complex capable of serving

supertankers. The project would enable oil from Iran to be stockpiled for transfer to smaller ships. The project, however, met with strong opposition from the High Chief of the islands and environmentalists from around the world. The Pacific Science Association and other scientific organizations requested abandonment of the project. Also, there was a move to petition the U.S. Department of Commerce to designate most of Palau's waters as a marine sanctuary.

The Mineral Industry of Rhode Island

By William R. Barton ¹

The value of Rhode Island mineral production increased 3% in 1976. The increase in value from \$6.2 million in 1975 to \$6.4 million in 1976 reflected activity in the construction industry. The monthly average index for value of total construction in Rhode Island was up from 102 in 1975 to 115.4 in 1976, although the index for nonbuilding construction declined from 95.6 to 88.7. Because sand and gravel and stone represent more than 99% of Rhode Island mineral production, mineral output follows construction activity.

Only about 5,000 pounds of new mineral materials, which consists entirely of sand and gravel, stone, and gem stones, are produced per capita each year in Rhode Island. About 40,000 pounds of new mineral materials are required annually on a per capita basis to maintain the living standard of the average U.S. citizen.

Rhode Island imports most of its mineral-derived needs, including all metals and mineral fuels. The State is entirely dependent upon mineral fuels produced elsewhere for its annual consumption of 187 trillion Btu's of energy. Eighty-eight percent of the energy requirement is derived from petroleum products including gasoline, and the remaining 12% from natural gas. There are no nuclear powerplants in Rhode Island, and only minor amounts of coal or coke are consumed for space heating and in foundries. Despite its deficiency in metallic and chemical raw mineral production, Rhode Island has heavy requirements for mineral industry products. About one-eighth of the manufacturing work force are employed in the production of stone, clay, glass, primary metals,

¹State Liaison Officer, Bureau of Mines, Newmarket, N.H.

Table 1.—Value of mineral production in Rhode Island, by county ¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Kent	\$2,523	\$1,193	Sand and gravel.
Newport	W	W	Stone, sand and gravel.
Providence	W	W	Sand and gravel, stone.
Washington	1,193	1,872	Sand and gravel.
Undistributed ²	2,482	3,334	
Total	6,198	6,399	
Total 1967 constant dollars	2,453	2,300	

^p Preliminary. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

¹ Bristol County is not shown because no production was reported.

² Includes gem stones and values indicated by symbol W.

Table 2.—Indicators of Rhode Island business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	426.1	430.0	+ .9
Unemployment -----do-----	59.4	35.0	-41.1
Employment (nonagricultural):			
Mining -----do-----	(¹)	(¹)	(¹)
Manufacturing -----do-----	112.7	122.4	+ 8.6
Contract construction -----do-----	11.5	12.0	+ 4.4
Transportation and public utilities -----do-----	13.3	13.5	+ 1.5
Wholesale and retail trade -----do-----	71.4	74.5	+ 4.3
Finance, insurance, real estate -----do-----	17.9	18.1	+ 1.1
Services ² -----do-----	65.8	68.8	+ 4.6
Government -----do-----	56.6	57.0	+ .7
Total nonagricultural employment -----do-----	349.2	366.3	+ 4.9
Personal income:			
Total -----millions--	\$5,342	\$5,866	+ 9.8
Per capita -----do-----	\$5,737	\$6,331	+ 10.4
Construction activity:			
Number of private and public residential units authorized--	3,360	4,572	+ 36.1
Value of nonresidential construction -----millions--	\$42.6	\$50.6	+ 18.8
Value of State road contract awards -----do-----	\$15.2	\$16.0	+ 5.3
Shipments of portland and masonry cement to and within the State -----thousand short tons--	145	147	+ 1.4
Mineral production value:			
Total crude mineral value -----millions--	\$6.2	\$6.4	+ 3.2
Value per capita, resident population -----do-----	\$7	\$7	--
Value per square mile -----do-----	\$5,105	\$5,272	+ 3.3

^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.

Table 3.—Worktime and injury experience in the Rhode Island mineral industry in 1976 ¹

	Men	Manhours	Fatal injuries	Fatal fre- quency rate	Non- fatal dis- abling injuries	Non- fatal dis- abling fre- quency rate	Nondis- abling injuries	Nondis- abling frequency rate
Sand and gravel:								
Surface -----	216	299,155	--	--	1	3.34	4	13.37
Office -----	63	69,706	--	--	--	--	--	--
Total -----	279	368,861	--	--	1	2.71	4	10.34
Limestone:								
Surface -----	4	7,302	--	--	--	--	--	--
Mill -----	13	25,211	--	--	--	--	--	--
Office -----	5	9,666	--	--	--	--	--	--
Total -----	22	42,179	--	--	--	--	--	--
Granite:								
Surface -----	3	1,437	--	--	--	--	--	--
Miscellaneous stone:								
Surface -----	19	15,063	--	--	--	--	--	--
Mill -----	7	11,969	--	--	--	--	--	--
Office -----	4	6,462	--	--	--	--	--	--
Total -----	30	33,494	--	--	--	--	--	--
State totals:								
Surface -----	242	323,007	--	--	1	3.10	4	12.38
Mill -----	20	37,180	--	--	1	26.90	--	--
Office -----	72	85,834	--	--	--	--	--	--
Total -----	334	446,021	--	--	2	4.48	4	8.97

¹ Data supplied by Mining Safety and Health Administration, U.S. Department of Labor.

or chemical products. These mineral derived products are, in turn, the raw materials for manufacturers of fabricated metal products, machinery, electrical and electronic equipment, jewelry, and transportation equipment which employ another fourth of the manufacturing work force in the State. These industries all rely, for continued operation, on mineral raw material produced elsewhere.

Coastal zone management programs were being devised by all of the New England Coastal States as mandated by Federal coastal zone legislation. The plans impacted on present and future mining activity with varying severity, but in all cases offered new restrictions or additional

operational requirements on mining. As a direct result of increasing coastal zone management and Outer Continental Shelf oil and gas interest, Professor Robert McMaster of the University of Rhode Island was designated Associate State Geologist for Marine Matters.

A visitor guide to mining and mineral operations in the northeast, including Rhode Island, was published by the Bureau of Mines.² The booklet described active and abandoned mining sites and camps that could be visited or easily viewed from major highways.

² U.S. Bureau of Mines. Mining and Mineral Operations in the New England and Mid-Atlantic States. A Visitor Guide. BuMines SP 10-76, 1976, 72 pp.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement and masonry cement into Rhode Island from domestic producers were 141,525 and 5,897 tons. These figures compared with 140,221 and 4,530 tons a year earlier. There are no cement producing plants in Rhode Island.

Gem Stones.—The value of gem stones and mineral specimens collected was estimated at a few thousand dollars in 1976.

Lime.—Shipments of lime into Rhode Island amounted to 8,605 tons in 1976 compared with 7,832 tons in 1975.

Sand and Gravel.—There were 30 active sand and gravel operations in Rhode Island in 1976. One operation produced both industrial and construction sand and gravel. The others produced construction aggregates exclusively. Leading producers were: A. Cardi Construction Co., Inc; River Sand and Gravel Co.; and Rhode Island Sand and Gravel Co.

Table 4.—Rhode Island: Construction and industrial sand and gravel sold or used by producers

Use	1976		Value per ton
	Quantity (thousand short tons)	Value (thousands)	
Construction:			
Sand	1,502	\$2,259	\$1.50
Gravel	1,413	2,548	1.80
Total ¹	2,914	4,805	1.65

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

Table 5.—Rhode Island: Construction sand and gravel sold or used by major use category

Use	1976		Value per ton
	Quantity (thousand short tons)	Value (thousands)	
Processed:			
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) ----	427	\$842	\$1.97
Concrete products (cement blocks, bricks, pipe, etc.) ---	681	1,112	1.63
Unprocessed:			
Asphaltic concrete aggregates and other bituminous mixtures -----	506	1,111	2.20
Roadbase and coverings -----	671	859	1.28
Fill -----	517	631	1.22
Other uses -----	116	252	2.17
Total ¹ -----	2,914	4,805	1.65

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

Stone.—Four companies produced stone in 1976. The Conklin Limestone Co., Inc. quarried and crushed marble at Ashton. The limestone was sold for rubble, agricultural limestone, terrazzo, roofing, filler, and flux purposes. M. A. Gammino Construction Co. produced granite at Cranston

for use as bituminous and concrete aggregate, roadbase stone, riprap, railroad ballast, and filter stone. Peckham Brothers Co., Inc. crushed quartzitic graywacke near Middletown for macadam aggregate and roadbase use. Gerald T. Kidd, Inc. produced granite riprap.

Table 6.—Rhode Island: Production of crushed stone, by use¹
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	168	W	90	W
Riprap -----	22	W	W	W
Concrete aggregate -----	31	W	68	W
Dense graded roadbase stone -----	32	W	35	W
Filter stone -----	6	W	20	W
Macadam aggregate -----	5	15	7	25
Railroad ballast -----	1	W	2	W
Other uses ² -----	29	1,110	83	1,270
Total -----	293	1,125	305	1,295

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

¹Includes granite, limestone, and miscellaneous stone.

²Includes stone used in agricultural limestone, roofing granules, flux stone, other filler, terrazzo (1975), and uses indicated by symbol W.

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

MINERAL FUELS

Statistics on Rhode Island fuel consumption are published annually by the New England Fuel Institute in the March issue of "Yankee Oilman." Data for 1974 were published in March 1976.

The Bureau of Mines published two reports detailing fuels and energy data by individual eastern States including Rhode

Island.³ Data for later years were published regularly in the Bureau of Mines "Mineral Industry Surveys" series. Another Bureau of Mines information circular

³Crump, L. H. Historical Fuels and Energy Consumption Data, 1960-72, United States by States and Census Districts East of the Mississippi. BuMines IC 8704, 1976, 456 pp.
———. Fuels and Energy Data: United States by States and Census Divisions, 1973. BuMines IC 8722, 1976, 112 pp.

presented the results of a June 1976 survey of planned or proposed coal mines, coal and noncoal conversion plants, oil refineries, uranium enrichment facilities, and related infrastructures.⁴

Anthracite.—Weston Observatory of Boston College began investigating the production potential of Narragansett Basin coals. Work was conducted under the direction of Professor James W. Skehan, S.J., using funds provided by the National Science Foundation, the New England Regional Commission, and local industry and government groups. Initial drilling at Portsmouth and Bristol located beds of good-quality semianthracite and anthracite (according to Bureau of Mines analyses), but at yearend sufficient drilling had not yet been accomplished to fully evaluate their continuity or full extent. Weston Observatory submitted an interim report on the work to the National Science Foundation. It was titled: "The Pennsylvanian Coal-Bearing Strata of the Narragansett Basin", NSF/RANN Document NSF/RA 76-0337. The report was on the work conducted under, or relating to, Grant No. AER 76-02147. The Bureau of Mines supported the project by providing coal analytical and coal cleaning services.

Petroleum.—The Rhode Island Department of Economic Development continued major efforts to attract support and construction activities ancillary to Outer Continental Shelf (OCS) development to abandoned Navy bases on Narragansett Bay. About 100 acres at Davisville were already being utilized for OCS service support and Brown & Root Inc. had started negotiations to site a platform fabrication yard in the Davisville area. About 30 petroleum-related companies hold leases on property or office space at Quonset or Davisville.

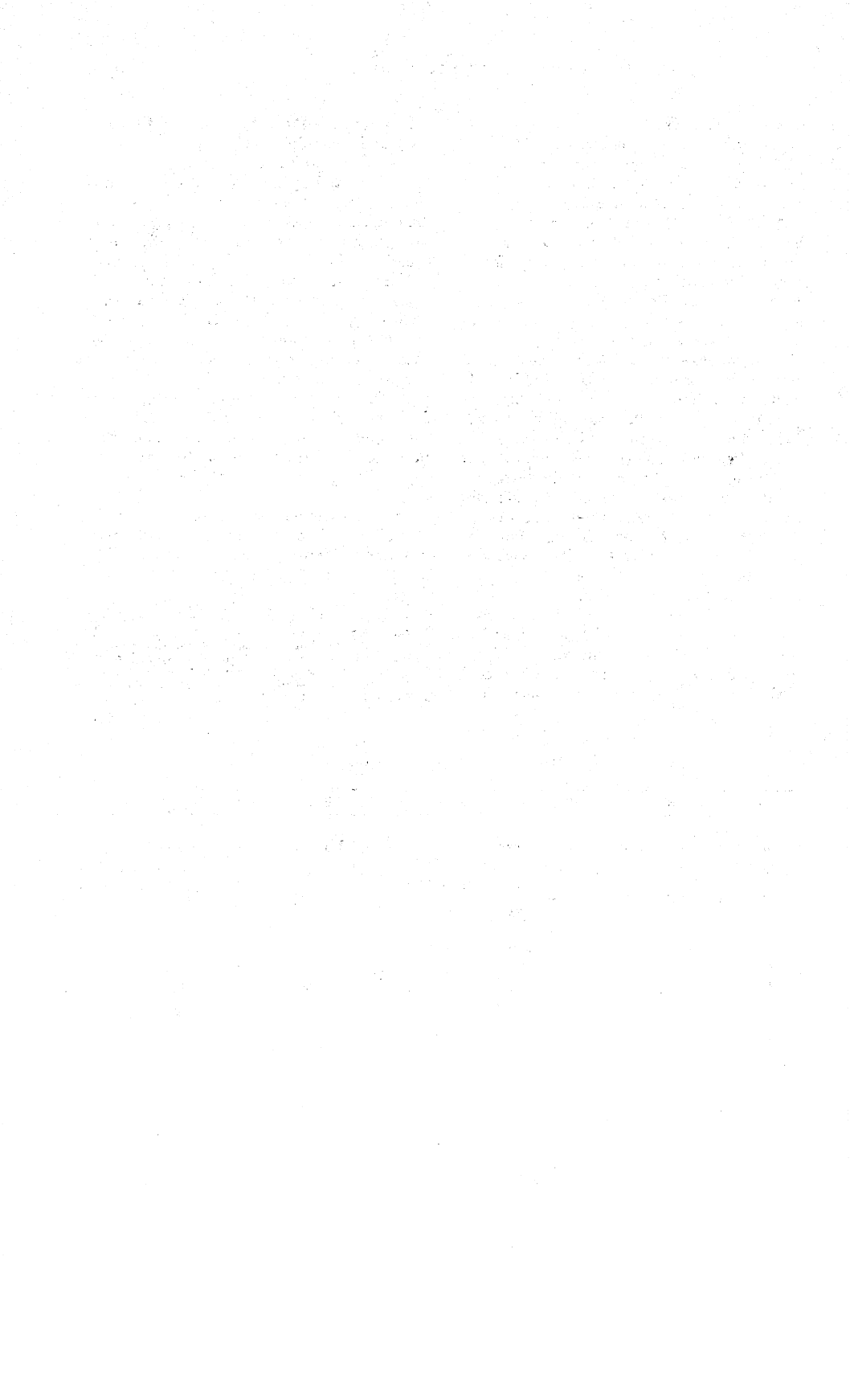
A Continental Offshore Stratigraphic Test (COST) hole was drilled on Georges Bank and a second such COST hole was planned. The surface support for the drilling was all provided out of the Rhode Island bases.

The semisubmersible oceangoing drill rig "Ocean Victory" was being refurbished at Quonset Point prior to drilling COST hole No. 2 on Georges Bank.

⁴ U.S. Bureau of Mines. Projects To Expand Fuel Sources in Eastern States. Survey of Planned or Proposed Coal Mines, Coal and Noncoal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilities, and Related Infrastructure, in States East of the Mississippi River (as of June 1976). BuMines IC 8725, 1976, 114 pp.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Sand and gravel:			
A. Cardi Construction Co., Inc.	451 Arnold Rd. Coventry, R.I. 02816	Pit -----	Kent.
River Sand & Gravel Co --	221 Benedict St. Pawtucket, R.I. 02864	----do -----	Washington.
Rhode Island Sand & Gravel Co., Inc.	Kilvert St. Warwick, R.I. 02886	----do -----	Kent.
Tasca Sand & Gravel Co.--	Box 113, R.F.D. 4 Mann School Rd. Esmond, R.I. 02917	----do -----	Providence.
Material Services, Inc ----	Greenville Rd. North Smithfield, R.I. 02895	----do -----	Do.
South County Sand & Gravel Co., Inc.	North Rd. Peace Dale, R.I. 02878	----do -----	Washington.
J. H. Lynch & Sons, Inc.--	Box 325 Ashton, R.I. 02864	----do -----	Providence.
Westerly Trucking Co ----	35 High St. Westerly, R.I. 02891	----do -----	Do.
Stone:			
Limestone crushed:			
The Conklin Limestone Co., Inc.	R.F.D. 1 Lincoln, R.I. 02860	----do -----	Do.
Granite and other stone:			
M. A. Gammino Construction Co.	875 Phenix Ave. Cranston, R.I. 02920	----do -----	Do.
Gerald T. Kidd, Inc --	67 Riverside Dr. Tiverton, R.I. 02878	----do -----	Newport.
Peckham Brothers Co., Inc.	Box 193 Newport, R.I. 02840	----do -----	Do.



The Mineral Industry of South Carolina

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey, State Development Board, for collecting information on all minerals except fuels.

By Hewson Lawrence ¹

The value of mineral production in South Carolina in 1976 continued the steady increase began in 1963, reaching a record \$125.5 million. Compared with production in 1975, output of cement, clays, sand and gravel, and mica (sericite), increased in both value and quantity; stone showed a production decrease while increasing in value; and vermiculite and peat production decreased in both quantity and value. Cement production continued to lead in dollar value as the principal mineral commodity in the State. Stone production continued to rank second in

value to cement production. Asphalt and brick and tile output was valued at over \$80 million. Iron, steel, and ferroalloys production approached 800,000 tons and was valued at over \$200 million.

The production of kaolin and vermiculite in South Carolina continued to rank second nationally in quantity and value, and that of crude mica (sericite) ranked high among the producing States in both quantity and value.

¹ State Liaison Officer, Bureau of Mines, Columbia, S.C.

Table 1.—Mineral production in South Carolina ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons..	² 1,698	² \$12,828	2,270	\$17,288
Gem stones -----	NA	5	NA	4
Manganiferous ore -----short tons..	500	W	9,000	W
Mica (scrap) -----do..	6,726	318	W	W
Peat -----thousand short tons..	18	W	15	W
Sand and gravel -----do..	7,363	14,128	7,887	17,154
Stone -----do..	13,836	30,082	13,027	30,690
Value of items that cannot be disclosed:				
Cement, clay (fuller's earth) (1975), vermiculite, and values indicated by symbol W -----	XX	^r 58,107	--	60,319
Total -----	XX	^r 115,468	XX	125,455
Total 1967 constant dollars -----	XX	45,691	XX	^p 45,101

^p Preliminary. ^r Revised. NA Not available. W Withheld to avoid disclosing individual company confidential data; values included with "Value of items that cannot be disclosed." 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 "Value of items that cannot be disclosed."

Note.—In the 1975 chapter, footnote 3 pertaining to stone should read excludes limestone rather than crushed and broken stone.

Table 2.—Value of mineral production in South Carolina, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Aiken	\$9,579	\$12,415	Clays, sand and gravel.
Anderson	754	W	Stone, sand and gravel.
Bamberg	W	W	Sand and gravel.
Berkeley	W	W	Stone.
Charleston	6	136	Sand and gravel.
Cherokee	W	W	Stone, clays, sand and gravel, manganiferous ore.
Chester	W	W	Sand and gravel.
Chesterfield	W	W	Sand and gravel, stone.
Colleton	W	W	Sand and gravel, peat.
Darlington	15	W	Sand and gravel.
Dillon	W	W	Do.
Dorchester	30,905	W	Cement, stone, clays, sand and gravel.
Edgefield	69	W	Clays.
Fairfield	W	W	Stone, sand and gravel.
Florence	W	327	Sand and gravel.
Georgetown	W	W	Stone, sand and gravel.
Greenville	W	W	Do.
Greenwood	W	W	Stone, clays, sand and gravel.
Horry	W	1,503	Clays, stone, sand and gravel.
Jasper	W	W	Sand and gravel.
Kershaw	W	W	Sand and gravel, clays, stone.
Lancaster	W	W	Clays, mica, sand and gravel.
Laurens	W	W	Vermiculite, stone.
Lee	W	100	Sand and gravel.
Lexington	W	W	Sand and gravel, stone, clays.
Marion	W	W	Clays, sand and gravel.
Marlboro	W	W	Sand and gravel, clays.
Newberry	W	W	Clays.
Oconee	334	159	Stone.
Orangeburg	25,008	26,135	Cement, stone, clays, sand and gravel.
Pickens	2,527	W	Stone.
Richland	W	W	Stone, clays, sand and gravel.
Saluda	W	16	Clays.
Spartanburg	W	W	Stone, sand and gravel.
Sumter	W	W	Sand and gravel, clays.
Union	--	26	Sand and gravel.
Williamsburg	W	W	Do.
York	W	W	Stone, clays, sand and gravel.
Undistributed ²	46,273	84,638	
Total	^r 3115,468	125,455	

¹ Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

² The following counties are not listed because no production was reported; Abbeville, Allendale, Barnwell, Beaufort, Calhoun, Clarendon, Hampton, and McCormick.

³ Includes gem stones and values indicated by symbol W.

⁴ Data do not add to total shown because of independent rounding.

In 1976, mineral commodities were produced by 130 companies, operating 250 mines located in 39 of the State's 46 counties. Sand (including gravel and sand-clay mixture) was the leading commodity ranked by the number of operating mines (130), followed by miscellaneous clay (50), crushed stone (33), processed kaolin (13), and vermiculite (12).

Aiken County led in the number of operating mines (25), followed by Kershaw (16), Charleston (15), and Cherokee and Lexington (14 each). No mineral production was reported in Abbeville, Allendale, Barnwell, Beaufort, Calhoun, Clarendon, Hampton, and McCormick Counties.

Union County reported production for 1976, no production was reported in 1975 for Clarendon and Union.

Three South Carolina mining firms transferred ownership during 1976: James H. Matthews Granite Quarry Corp. bought Kershaw Granite Co.'s Kershaw and Congaree quarries; McDaniel Sand and Gravel Co. bought M. O. Parsons Sand Co. in Georgetown County; and Vulcan Materials Co. purchased the Clover quarry at Blythe Bros. Construction Co. of Charlotte, N.C.²

² Department of Mining and Reclamation, South Carolina Land Resources Conservation Commission Geologic Notes (South Carolina Geological Survey, State Development Board), v. 21, No. 1, 1977, p. 14.

Table 3.—Indicators of South Carolina business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	1,181.0	1,256.0	+6.4
Unemployment -----do-----	103.0	87.0	-15.5
Employment (nonagricultural):			
Mining -----do-----	1.9	1.8	-5.3
Manufacturing -----do-----	339.9	370.5	+9.0
Contract construction -----do-----	61.8	61.4	-.6
Transportation and public utilities -----do-----	40.5	42.8	+5.7
Wholesale and retail trade -----do-----	175.6	188.3	+7.2
Finance, insurance, real estate -----do-----	39.1	39.6	+1.3
Services -----do-----	123.9	133.2	+7.5
Government -----do-----	199.8	201.7	+1.0
Total nonagricultural employment -----do-----	1,982.6	1,039.3	+5.8
Personal income:			
Total -----millions--	\$13,093	\$14,662	+12.0
Per capita -----do-----	\$4,650	\$5,147	+10.7
Construction activity:			
Number of private and public residential units authorized --	15,358	18,399	+19.8
Value of nonresidential construction -----millions--	\$84.1	\$128.4	+52.7
Value of State road contract awards -----do-----	\$114.4	\$120.1	+5.0
Shipments of portland and masonry cement to and within the State -----thousand short tons--	909	901	-.9
Mineral production value:			
Total crude mineral value -----millions--	\$115.5	\$125.5	+8.6
Value per capita, resident population -----do-----	\$41	\$44	+7.3
Value per square mile -----do-----	\$3,718	\$4,040	+8.7

^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.

In October, an agreement in principle was reached between Guignard Brick Works, Inc., of Columbia and Merry Companies, Inc., of Augusta, Ga. to purchase inventory and receivables and lease the plant and other assets for 5 years with an option to purchase the remaining Guignard property in 1981.³

Trends and Developments.—Prospecting within the State was highlighted by increased exploration for uranium in the Piedmont and Blue Ridge areas as well as in certain Atlantic coastal plain locations. Gold, which was mined until World War II (State Geological Survey Bulletin 32 of 1966 listed 135 abandoned gold mines), is still receiving attention. The very large kaolin deposits that exist within the State offer future potential as a source of alumina. The alumina content of the kaolin is high, and if the price of bauxite imported from foreign sources continues to rise, it may become economically attractive to mine the kaolin for this purpose.

Heavy-mineral deposits containing titanium, zirconium, thorium, and rare earths

are receiving continuing interest because of the greatly increased use of rare earths in color television sets and miniaturized electronic equipment such as hand-held calculators. Significant heavy mineral deposits are located in the flood plains of various parts of the State, coastal wetlands, and the sea islands. A cooperative agreement between the Coastal Plains Regional Commission and the U.S. Geological Survey resulted in completion of aeromagnetic and aeroradioactivity mapping of the eight South Carolina coastal plain counties. "Aerorad" and "aeromag" map prints are now available from the South Carolina Geological Survey, Harbison Forest Road, Columbia, S.C. 29210.

Legislation and Government Programs.—Under the South Carolina Mining Act of 1974, requiring each mining operation prior to mining to file for a permit including a reclamation plan, a total of 69 mining permit applications were received and 66 permits were issued for 1976.

³ Work cited in footnote 2.

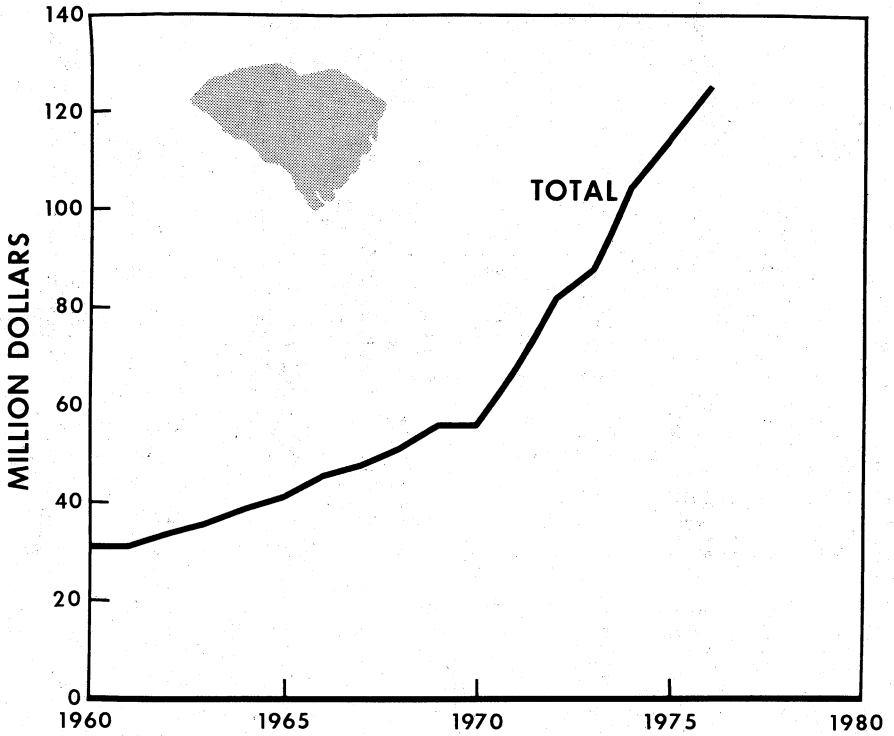


Figure 1.—Total value of mineral production in South Carolina.

With reclamation and environmental protection (including water quality) now a fact of law and with increased demands on available land, many mining companies are now integrating reclamation objectives into their mine development plans. Mining is now seen as a process that develops the land for subsequent uses. Reclamation was highlighted by the planting of 383 acres

with permanent vegetation. Substantial numbers and amounts of access roads, benches, earth embankments, fencing, temporary vegetation, ponds, visual screening, surface grading, and terracing were completed.⁴

⁴ South Carolina Mining and Reclamation Division.

The mining act is under the administration of the Mining and Reclamation Division of the South Carolina Land Resources Conservation Commission. The staff includes six professionals and two support personnel. Additionally, a 32-member Technical Advisory Committee composed of various staff members from State and Federal agencies lends support to the Mining Division.

The South Carolina Geological Survey, a division of the State Development Board, continued its ongoing collection and evaluation of basic geologic data during 1976.⁵

More than 88 geologic and geophysical field investigations were continued or initiated by the 5 full-time division geologists, 2 geologic technicians, 13 project geologists (mostly university faculty), and consultants. Some important projects follow: (1) Geologic map of South Carolina, (2) geology and mineral resources of Chesterfield County, (3) South Carolina major structures—determination of fault and fracture zones, (4) earthquake history of South Carolina, and (5) geologic cross section along Intracoastal Waterway.

Geologic field and office assistance was provided to 37 different industrial prospects requesting data on 18 various mineral categories. Uranium, base metals (copper, lead, zinc), and phosphate led the number of requests, followed by gold,

heavy minerals, limestone, mica (sericite), and granite (both crushed and dimension).

Other requests included information on oil and gas (potential, legislative status, and related items) and subsurface geologic data for waste disposal (both solid and liquid).

Mineral resource projects conducted independently of requests from industries included barite, kaolin, limestone, nickel, and silica sand.

Projects completed during 1976 and in preparation for publication were: Granitic Stone Resources of South Carolina, by H. D. Wagener; Mineral Resources and Mineral Industries Map of South Carolina, by W. M. Rivers; Geology of the Salem Quadrangle, by R. D. Hatcher, Jr.; Geology of the Irmo and Lake Murray East Quadrangles, by J. D. Tewhey; and Geology of the Calhoun Creek, Calhoun Falls, Chennault and Verdery Quadrangles, by V. S. Griffin, Jr.

The Survey released a number of new publications during 1976, including four volumes of Geologic Notes containing 13 articles and a field trip guidebook, Introduction to the Geology of the Eastern Blue Ridge of the Carolinas and nearby Georgia.

⁵ Olson, N. K. Geologic Activities in South Carolina During 1976. Geologic Notes (South Carolina Geological Survey, State Development Board), v. 21, No. 1, 1977, pp. 2-12.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Cement output continued to rank first in value of mineral production. Portland and masonry cements were produced by Giant Portland Cement Co. and Gifford-Hill Cement Co. in Dorchester County and Santee Portland Cement Co. in Orangeburg County. Each company, in addition to producing cement, mined marl and miscellaneous clays as raw materials for the manufacture of the cement. Approximately 92% of the portland cement shipped was types I and II and was used principally for ready-mix concrete products and concrete products manufacture. Smaller amounts were sold for use in highway construction and to building material dealers and other contractors. More than 93% of the portland cement shipments

were in bulk, and the majority was transported by truck.

Clays.—Clay production included processed kaolin, miscellaneous clays used for the manufacture of brick and cement, and fuller's earth used as an absorbent. Total clay production (including fuller's earth) ranked fourth in value of mineral commodities produced in South Carolina and amounted to 2.27 million tons valued at \$17.29 million.

Processed kaolin is produced only in Aiken County by 5 firms operating a total of 13 mines. South Carolina continued to rank second to Georgia in the production of kaolin in both quantity and value. Air-floated kaolin was used principally in rubber products, paints, high-quality paper and fertilizers, pesticides, brick, fungicides,

and adhesives. Water-washed kaolin was produced by one company for paper coating.

Miscellaneous clay was used almost entirely in the manufacture of brick. Some of the unprocessed kaolin was used in refractories and sanitary ware, as a colorant in brick, and in the manufacture of cement. Miscellaneous clay was produced from 50 mines in 17 counties. The leading producers of miscellaneous clays were Richtex Corp., Southern Brick Co., Giant Portland Cement Co., Gifford-Hill & Co., Inc., Palmetto Brick Co., and Santee Portland Cement Co.

Three new mining operations were begun in 1976. Guignard Brick Works, Inc., opened a kaolin mine in Lexington County, South Carolina Electric and Gas Co. opened a clay mine for construction at the V. C. Summer Nuclear Station in Fairfield County, and Johnnie Tindell Construction Co. opened a clay pit in Aiken County.

South Carolina ranked fifth in the production of brick (building or common and face), according to data published by the U.S. Bureau of the Census. North Carolina, South Carolina, and Virginia comprise a regional marketing area which accounted for approximately 25% of the shipments of brick in 1976 in the United States.

Fuller's earth was produced at one mine in Sumter County and was sold chiefly for use as an absorbent in various oil and grease and pet products.

Colemanite.—Industrial Minerals, Inc., York, processed colemanite (calcium borate) ore from Turkey in its Cherokee County plant. The ore is ground, dried, and shipped to PPG Industries, Inc., and Owens Corning for use in textile fibers.

Feldspar.—Spartan Minerals Co. (a division of Lithium Corp. of America) produced a feldspar-silica mixture from tailings shipped to Pacolet, from the Lithium Corp. spodumene operation in North Carolina. The feldspar-silica mixture was sold for use in glass containers, in ceramic whiteware, and as a latex filler. No feldspar is currently being mined in South Carolina.

Mica (Sericitic).—The Mineral Mining Corp. in Lancaster County mined and processed sericitic by dry-milling sericitic-

rich ores and producing a micaceous product which was sold mainly for use in paint, expansion joint cement, and electronics. Although Mineral Mining Corp. is the only processor of the sericitic-rich ores, numerous other deposits are mined for use in the manufacture of brick. Production increased in both quantity and value from that of 1975.

Manganiferous Ore.—Manganiferous schist, associated with the manganiferous member of the Battleground Schist of the Kings Mountain area, was mined in Cherokee County by brick manufacturers or contractors for use in coloring brick at South and North Carolina brick plants. Material from some pits has an average manganese content greater than 5% but less than 10% (or possibly 15% at the most). Material from other pits had less than 5% manganese. The total quantity mined in 1976 is estimated at 9,000 tons.

Sand and Gravel.—Producers of sand and gravel in South Carolina include those companies that produce both commodities, those that produce only gravel, those that produce only sand, and also producers of fill material, a product that contains a sand-clay mixture. Whether or not gravel is produced depends upon the location of the mining operation in the State, since most sand deposits do not contain any gravel-size components.

Total production of sand and gravel increased approximately 7% to 7.89 million tons and approximately 21% in value to \$17.15 million. Sand and gravel ranked third in value of mineral commodities produced in South Carolina. Most of this production is from "sand only" operations. Sand and gravel was sold for use mainly in concrete aggregate, concrete products, and fill. Industrial sand was sold for use in glassmaking, chemicals, sand blasting, porcelain and tile, foundry, and filtration. Most sand and gravel was shipped by truck.

During 1976, 10 new sand, 2 new sand and gravel, and 7 new sand-clay mining operations came into production. During the same period, six sand-clay mines closed or were mined out.

Pennsylvania Glass Sand Corp. in Lexington County mined and processed a high-quality silica sand for use in the glass, fiber glass, ceramic, and chemical industries in the Southeast. Wedron Silica Div.,

Table 4.—South Carolina: Construction and industrial sand and gravel sold or used by producers

(Thousand short tons and thousand dollars)

Use	1976		Value per ton
	Quantity	Value	
Construction:			
Sand -----	5,512	6,728	1.22
Gravel -----	1,597	5,075	3.18
Total or average ¹ -----	7,110	11,802	1.66
Industrial:			
Sand -----	769	5,307	6.90
Gravel -----	8	45	5.63
Total or average -----	777	5,352	6.89
Grand total or average -----	7,887	17,154	2.18

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

Table 5.—South Carolina: Construction sand and gravel sold or used, by major use category

(Thousand short tons and thousand dollars)

Use	1976		Value per ton
	Quantity	Value	
Concrete aggregate:			
Residential, nonresidential, highways, bridges, dams, waterworks, airports, etc -----	1,998	4,164	2.08
Concrete products:			
Cement blocks, bricks, pipe, etc -----	1,812	4,108	2.27
Asphaltic concrete aggregates and other bituminous mixtures -----			
Roadbases and coverings -----	667	1,388	2.08
Fill -----	426	393	.92
Other uses -----	1,025	770	.75
Total ¹ -----	1,184	980	.83
Total ¹ -----	7,110	11,802	1.66

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

Del Monte Properties Co. in Kershaw County processed silica sand for glassmaking.

Charleston County had the most operating mines (17), followed by Aiken and Lexington (11 each) and Horry (9). However, according to total quantity of production, Lexington was the leading county, followed by Marlboro, Sumter, Chesterfield, and Charleston.

Stone.—The value of stone production continued to rank second behind cement and accounted for 24% of the total value of mineral production in the State. Crushed stone production decreased 6% in quantity to 13,010,000 tons but increased approximately 1% in value to \$29,790,000. Crushed stone was produced at 33 quarries by 18 companies in 19 counties. Richland, Dorchester, Pickens, Lexington, and Fairfield Counties each produced over 1 million tons. Most of the stone mined was granite. Several companies produced lime-

stone, and a few companies mined marl or coquina (shell limestone). Vulcan Materials Co., Martin Marietta Corp., and Lone Star Industries were the leading producers.

Crushed granite was used for roadbase, stone, concrete, bituminous and macadam aggregate, railroad ballast, and riprap. Most of the crushed granite was shipped by truck.

Crushed limestone and coquina were used for roadbase stone, agricultural limestone, concrete, and bituminous aggregate.

Crushed marl produced by three cement companies was used in the manufacture of portland cement.

Dimension granite was produced by Granite Quarry Corp., Winnsboro Granite Co., and Comolli Granite Co. from five quarries in Fairfield and Kershaw Counties for use in monumental stone and rough blocks. Output expanded 80% to 16,860 tons valued at \$899,600.

Table 6.—South Carolina: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Roadstone -----	1,790	4,692	3,892	10,030
Concrete aggregate -----	2,120	4,841	2,349	5,929
Cement manufacture -----	1,997	2,424	2,201	2,624
Bituminous aggregate -----	1,884	4,512	1,488	3,707
Macadam aggregate -----	994	2,082	1,416	2,796
Dense-graded roadbase stone -----	4,294	9,295	730	1,853
Railroad ballast -----	180	438	267	732
Riprap and jetty stone -----	224	429	96	247
Other uses ² -----	343	874	571	1,875
Total³ -----	13,830	29,590	13,010	29,790

¹Includes marl, limestone, granite, and shell.

²Includes agricultural limestone, surface treatment aggregate, and other uses (1976).

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

Two companies opened new mining operations. Coast Limestone Co. produced coquina from two quarries in Horry County, and Ware Bros. Construction Co. started mining limestone from a quarry in Berkeley County.

Among all the States, South Carolina led in marl products, ranked fourth in output of crushed granite, and was fifth in coquina.

Vermiculite.—Production of crude vermiculite decreased approximately 24% in quantity and nearly 17% in value. Exfoliated vermiculite sold or used increased slightly in both quantity and value. Crude vermiculite was mined by W. R. Grace & Co. from five mines in Laurens County and from six mines in Spartanburg County. The ore was exfoliated at two plants, one each in Greenville and Laurens Counties. Patterson Vermiculite Co. mined crude vermiculite from one mine in Laurens County and exfoliated the ore in a plant in the same county. Principal uses of exfoliated vermiculite are for soil conditioning additives, for manufacture of lightweight aggregates (concrete, plaster, and fireproofing), and in loose and block insulation. Crude vermiculite production in South Carolina is second to that of Montana, the only other producing State.

Zircon.—Milled zircon (zirconium silicate) was produced by M & T Chemicals, Inc., in Georgetown County using raw materials obtained from Florida, Georgia, and Australia. Zircon concentrates are processed by fine grinding (dry and wet with chemicals added) and shipped for foundry, wall tile, whiteware, and general ceramic uses.

METALS

No metals were mined in South Carolina in 1976. Metal ores formerly mined included gold, tin, lead, manganese, and copper. However, iron, steel, and ferroalloys production from ores obtained from out-of-State sources is estimated at 800,000 tons with a value of over \$200 million.

Ferroalloys.—Special ferroalloys were produced by Airco Alloys and Carbide, Division of Airco, Inc., in Charleston using ore from the U.S.S.R., Turkey, Southern Rhodesia, Republic of South Africa, India, Iran, Albania, and several other countries.

Iron and Steel.—Steel was produced in Georgetown by the Georgetown Steel Co., a subsidiary of Korf Industries of West Germany. Raw material for the steel manufacture was in the form of prerduced pellets made by the Mildrex process. This steel plant is one of two U.S. plants that currently use this process, which allows a high-quality steel to be produced in electric arc furnaces without coke ovens or blast furnaces. Georgetown Steel Co. has become the Nation's second largest producer of wire rod. Owen Electric Steel, Georgetown Steel, and Nucor Steel utilized iron and steel scrap for producing a variety of products.

MINERAL FUELS

There was no production of mineral fuels except peat in South Carolina during 1976.

Peat.—Crude peat was mined from a bog near Green Pond, Colleton County, by United States Peat Corp. and hauled to the company's processing and shipping

plant at Green Pond. The change in mining method during 1974 from cultivating and drying the peat to dredging and decanting the peat continues to effect economies in production. The crude peat is mixed with special additives at the processing plant, bagged, and shipped to consumers for use in general soil improvement.

Power Generation.—The consumption

of coal to generate power exceeded 5,550,000 tons during 1976 and represented approximately 35% of the fuel used for thermal electricity generation. Natural gas accounted for approximately 1%, oil for approximately 7%, nuclear for approximately 49%, and hydroelectric facilities for approximately 8% of the total power generated.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Giant Portland Cement Co.	Box 218 Harleyville, S.C. 29448	Plant -----	Dorchester.
Gifford-Hill & Co., Inc. ---	Box 326 Harleyville, S.C. 29448	---do -----	Do.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	---do -----	Orangeburg.
Clays:			
Common clay and shale:			
Giant Portland Cement Co.	Box 218 Harleyville, S.C. 29448	Mine -----	Dorchester.
Gifford-Hill & Co., Inc.	Box 326 Harleyville, S.C. 29448	---do -----	Orangeburg.
Palmetto Brick Co. ---	Box 430 Cheraw, S.C. 29520	---do -----	Kershaw and Marlboro.
Richtex Corp. -----	Box 3307 Columbia, S.C. 29230	---do -----	Fairfield, Lexington, Richland.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	---do -----	Orangeburg.
Southern Brick Co. ----	Box 208 Ninety Six, S.C. 29666	---do -----	Aiken, Greenwood, Newberry, Saluda.
Fuller's earth:			
Bennett Mineral Co. ---	Box 158 Pinewood, S.C. 29125	Mine and plant ---	Sumter.
Kaolin, processed:			
Dixie Clay Co., a division of R. T. Vanderbilt Co.	Box B Bath, S.C. 29816	---do -----	Aiken.
J. M. Huber Corp. ----	Box 306 Langley, S.C. 29834	---do -----	Do.
Colemanite:			
Industrial Minerals, Inc. --	Box 459 York, S.C. 29745	Plant -----	Cherokee.
Feldspar, crude:			
Spartan Minerals Co., a division of Lithium Corp. of America.	Box 520 Pacolet, S.C. 29372	---do -----	Spartanburg.
Manganiferous ore:			
Broad River Brick Co. ----	Box 550 Gaffney, S.C. 29340	Mine -----	Cherokee.
Mica (sericite):			
Mineral Mining Corp. ----	Box 458 Kershaw, S.C. 29067	Mine and plant ---	Lancaster.
Peat:			
United States Peat Corp. --	Box 245 Green Pond, S.C. 29446	Bog and plant ----	Colleton.
Sand and gravel:			
Addco Mining Co. -----	4142 Dorchester Rd. Charleston, S.C. 29405	Pit and plant ----	Dorchester.
Becker Sand & Gravel Co., a division of Gifford-Hill & Co., Inc.	Box 848 Cheraw, S.C. 29520	---do -----	Chesterfield, Colleton, Dorchester, Florence, Marlboro, Sumter.
Brewer Sand Co., Inc. ----	Rt. 2 Lancaster, S.C. 29720	---do -----	Chesterfield.
Deerfield Sand & Mining Co.	Box 580 Ridgeland, S.C. 29936	---do -----	Jasper and Orangeburg.
Foster-Dixiana Sand Co. --	Box 5447 Columbia, S.C. 29250	---do -----	Lexington.
Lone Star Industries, Inc. -	Box 5185 Columbia, S.C. 29205	---do -----	Richland.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Metromont Sand Corp., a division of Metromont Materials Corp.	Box 1292 Spartanburg, S.C. 29304	Pit and plant ----	Anderson, Cherokee, Spartan- burg.
McDaniels Sand & Gravel Co., Inc.	Box 497 Andrews, S.C. 29510	----do -----	Georgetown and Williams- burg.
Pennsylvania Glass Sand Corp.	Box 84 Cayce, S.C. 29033	----do -----	Lexington.
Stone:			
Granite, crushed and broken:			
Lone Star Industries, Inc.	Box 5185 Columbia, S.C. 29205	Quarry -----	Fairfield, Greenwood, Laurens, Richland.
Martin Marietta Aggregates.	Box 1758 Columbia, S.C. 29202	----do -----	Lexington, Richland, York.
Vulcan Materials Co --	Box 188 Blacksburg, S.C. 29702	----do -----	Greenville, Laurens, Pickens, Spartan- burg.
Granite, dimension:			
Comolli Granite Co ---	RFD 2, Box 297 Kershaw, S.C. 29067	----do -----	Kershaw.
Granite Quarry Corp --	Penn Circle E. Pittsburgh, Pa. 15206	----do -----	Do.
Winnsboro Granite Corp.	Rion, S.C. 29132 -----	----do -----	Fairfield.
Limestone, crushed:			
Martin Marietta Aggregates.	Box 1758 Columbia, S.C. 29202	Quarry and plant..	Berkeley and Georgetown.
Vulcan Materials Co --	Box 188 Blacksburg, S.C. 29702	----do -----	Cherokee.
Marl, crushed:			
Giant Portland Cement Co.	Box 218 Harleyville, S.C. 29448	Pit -----	Dorchester.
Gifford-Hill & Co., Inc.	Box 326 Harleyville, S.C. 29448	Pit -----	Do.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	Pit -----	Orangeburg.
Coquina (shell limestone), crushed:			
Cedar Creek Village, a division of Waccamaw Construction Co.	North Myrtle Beach, S.C. 29582.	Quarry -----	Horry.
Martin Marietta Aggregates.	Box 1758 Columbia, S.C. 29202	Quarry and plant..	Georgetown.
Vermiculite, crude and exfoliated:			
W. R. Grace & Co -----	Rt. 1 Enoree, S.C. 29335	Mine and plant ---	Greenville, Laurens, Spartan- burg.
Patterson Vermiculite Co..	----do -----	----do -----	Laurens.

The Mineral Industry of South Dakota

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota State Geological Survey for collecting information on all minerals.

By James H. Aase¹ and Patricia A. La Tour²

The value of mineral production in South Dakota for 1976 was \$101.5 million, a 0.3% decline from that of the previous year and a \$1.28 million decrease from the alltime high record value set in 1974. Metals, principally gold, accounted for 41%, nonmetals, 53%, and petroleum, 6% of the total mineral output value in 1976. Gold continued as the State's leading mineral commodity in terms of value, followed in order by cement, stone, sand and gravel, and petroleum.

Nationally, South Dakota ranked first among the States in gold production for the year, with the Homestake mine at Lead accounting for the total State output. Although the quantity of gold produced increased 4.4% from the 1975 level, the value of 1976 production was 19% lower owing to major decreases in gold prices, the average down about \$36 to \$125 per troy ounce.

The State-owned and operated cement plant, located in Rapid City, was nearing completion of an expansion project, initiated in 1974, to double its annual production capacity for cement from 3 to 6 million barrels. Value of the processed material from this expanded facility, when

operating at full capacity, is expected to be near \$40 million annually.

Exploration for oil and gas during 1976 reached the highest point in 6 years. A total of 39 test holes were drilled, which resulted in 1 new oil discovery well and 7 field development wells. The deepest test hole, drilled to 9,771 feet, set a new depth record in the State.

A \$14-million environmental improvement project was initiated at Homestake Mining Co.'s gold mine in Lead. The project involved constructing a tailings dam and other necessary site facilities needed to solve the company's water pollution problems that resulted from tailings discharges into Black Hills streams.

Testing continued at Conoco Coal Development Co.'s coal gasification pilot plant, located in Rapid City, using a variety of feedstocks to produce high-Btu gas by the carbon dioxide acceptor process. Feedstocks successfully used included two types of lignite from North Dakota and one from Texas, and two types of bituminous coal from Montana and one from Wyoming.

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² Liaison Program Assistant, Bureau of Mines, Rapid City, S. Dak.

Table 1.—Mineral production in South Dakota ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ² ----- thousand short tons--	187	\$185	124	\$137
Gem stones -----	NA	42	NA	44
Gold (recoverable content of ores, etc.) -----				
troy ounces--	304,935	49,244	318,511	39,916
Gypsum ----- thousand short tons--	23	60	W	W
Petroleum (crude) -----				
thousand 42-gallon barrels--	472	5,996	447	5,519
Sand and gravel ----- thousand short tons--	6,481	8,668	5,763	8,057
Silver (recoverable content of ores, etc.) -----				
thousand troy ounces--	68	299	58	253
Stone ----- thousand short tons--	2,647	15,350	3,241	17,240
Value of items that cannot be disclosed:				
Beryllium concentrate, cement (masonry and portland), clays (bentonite), feldspar, iron ore, lime, mica (scrap), natural gas liquids, and values indicated by symbol W -----	XX	21,977	XX	30,364
Total -----	XX	101,821	XX	101,530
Total 1967 constant dollars -----	XX	40,291	XX	^P 36,500

^P Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes bentonite; value included with "Value of items that cannot be disclosed."

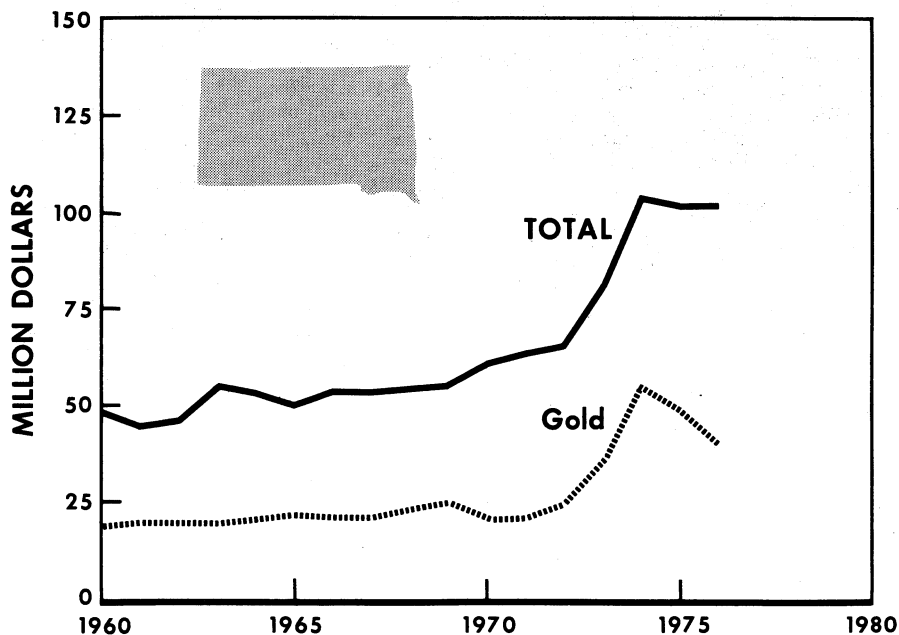


Figure 1.—Value of mine production of gold and total value of mineral production in South Dakota.

Table 2.—Value of mineral production in South Dakota, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Aurora -----	\$15	\$15	Sand and gravel.
Beadle -----	20		
Bon Homme -----	17	15	Do.
Brookings -----	488	375	Do.
Brown -----	473	298	Do.
Brule -----	37	--	
Buffalo -----	W		
Butte -----	W	W	Clays, natural gas liquids, sand and gravel.
Campbell -----	38	57	Sand and gravel.
Charles Mix -----	231	139	Do.
Clark -----	23	79	Do.
Clay -----	30	W	Do.
Codington -----	1,054	W	Do.
Corson -----	35	21	Do.
Custer -----	W	W	Stone, feldspar, petroleum.
Davison -----	30	28	Sand and gravel.
Day -----	74	57	Do.
Deuel -----	644	165	Do.
Dewey -----	W	W	Petroleum, sand and gravel.
Douglas -----	W	W	Sand and gravel.
Fall River -----	W	W	Sand and gravel, stone.
Faulk -----	--	30	Sand and gravel.
Grant -----	W	W	Stone, sand and gravel.
Gregory -----	81	77	Sand and gravel.
Haakon -----	9	9	Do.
Hamiin -----	47	28	Do.
Hand -----	82	W	Do.
Hanson -----	W	W	Stone, sand and gravel.
Harding -----	W	W	Petroleum, sand and gravel.
Hutchinson -----	84	63	Sand and gravel.
Hyde -----	75	60	Do.
Jerauld -----	17	24	Do.
Jones -----	--	6	Do.
Kingsbury -----	34	15	Do.
Lake -----	145	W	Do.
Lawrence -----	49,919	W	Gold, iron ore, sand and gravel, stone, silver.
Lincoln -----	112	82	Sand and gravel.
Lyman -----	W	96	Do.
McCook -----	39	--	
Marshall -----	60	W	Do.
Meade -----	W	W	Do.
Mellette -----	115	--	
Miner -----	22	--	
Minnehaha -----	W	W	Stone, sand and gravel.
Moody -----	102	99	Sand and gravel.
Pennington -----	22,310	28,550	Cement, lime, stone, sand and gravel, clays, gypsum, beryllium.
Perkins -----	362	334	Sand and gravel.
Potter -----	45	28	Do.
Roberts -----	302	412	Do.
Sanborn -----	W	4	Do.
Spink -----	W	W	Do.
Sully -----	45	30	Do.
Tripp -----	W	W	Sand and gravel, stone.
Union -----	55	60	Sand and gravel.
Walworth -----	75	W	Do.
Yankton -----	W	W	Sand and gravel, stone.
Ziebach -----	18	W	Sand and gravel.
Undistributed ² -----	24,455	70,271	
Total ³ -----	101,821	101,530	

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

¹The following counties are not listed because no production was reported: Bennett, Edmunds, Hughes, Jackson, McPherson, Shannon, Stanley, Todd, Turner, and Washabaugh.

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

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

Table 3.—Indicators of South Dakota business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	299.2	311.0	+3.9
Unemployment -----do-----	14.0	11.0	-21.4
Employment (nonagricultural):			
Mining -----do-----	2.6	2.6	--
Manufacturing -----do-----	19.8	22.2	+12.1
Contract construction -----do-----	10.2	11.2	+9.8
Transportation and public utilities -----do-----	12.1	12.1	--
Wholesale and retail trade -----do-----	56.5	60.8	+7.6
Finance, insurance, real estate -----do-----	9.0	9.5	+5.6
Services -----do-----	43.4	45.0	+3.7
Government -----do-----	55.7	55.8	+2
Total nonagricultural employment -----do-----	209.3	219.2	+4.7
Personal income:			
Total -----millions--	\$3,411	\$3,512	+3.0
Per capita -----do-----	\$5,011	\$5,120	+2.2
Construction activity:			
Number of private and public residential units authorized -----	3,103	4,777	+53.9
Value of nonresidential construction -----millions--	\$44.8	\$51.3	+14.5
Value of State road contract awards -----do-----	\$39.8	\$45.0	+13.1
Shipments of portland and masonry cement to and within the State -----thousand short tons--	322	383	+18.9
Mineral production value:			
Total crude mineral value -----millions--	\$101.8	\$101.5	-.3
Value per capita, resident population -----do-----	\$150	\$148	-1.3
Value per square mile -----do-----	\$1,321	\$1,318	-.2

^P Preliminary.

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

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Production of cement in 1976 increased 27% above the 1975 level. All of the production came from the State-owned Rapid City plant operated by the South Dakota Cement Commission. The disposition of finished portland cement shipments was 57% to ready-mix companies, 26% to highway contractors, 10% to concrete product manufacturers, 4% to building material dealers, and the remainder to other various customers.

Clays.—Total output of clays in 1976 declined 9% below that of 1975. Bentonite production accounted for the largest part of the value of clays produced in 1976. Principal uses of the bentonite produced were in oil well drilling muds, waterproofing sealants, and foundry sands. American Colloid Co. continued to operate the State's only bentonite-processing plant, at Belle Fourche, using crude material obtained from within the State and Wyoming sources.

Common clay production for cement manufacturing, lightweight aggregate, and brickmaking decreased about 34% in 1976 compared with that of 1975.

Feldspar.—Production of crude feldspar in 1976 was greater in quantity but lower in value compared with that of 1975. Pacer Corp., operators of a grinding mill at Custer, processed the bulk of the crude feldspar output.

Gypsum.—The State's production of gypsum was greater in quantity but lower in value compared with that of 1975. The South Dakota Cement Commission was the operator of two surface mines in Pennington County that provided the entire State output. Total output was used in manufacturing of cement.

Lime.—Pete Lien & Sons, Inc., produced lime at its plant located in Pennington County for soil stabilization, electric furnaces, sewage treatment, and other uses. Output was lower in quantity but higher in value compared with that of 1975.

Sand and Gravel.—Production of sand and gravel in 1976 decreased 11% in quantity and 7% in value compared with that of 1975. Output totaling 5.7 million tons was produced from 136 operations located in 50 counties during 1976. Minnehaha was the leading county in production, followed respectively by Pennington, Coding-

ton, Brookings, Brown, Fall River, and Lawrence, accounting for nearly half of the State total.

Stone.—Stone production consisting of granite, quartzite, limestone, and quartz was produced from 26 quarries in 9 counties. Output in 1976 amounted to 3.24 million tons valued at \$17.2 million, which represents a 22% increase in quantity and a 12% increase in value compared with that of 1975.

Granite was quarried at seven operations

by five companies all located in Grant County. The principal usage was for monumental and architectural purposes. It accounted for 60% of the total value of stone produced.

Crushed and broken stone accounted for nearly 99% of the total output. Approximately 29% was used as concrete aggregate, 21% in cement manufacturing, 10% for railroad ballast, and the remainder in other miscellaneous uses.

Table 4.—South Dakota: Construction sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1976		Value per ton
	Quantity	Value	
Construction:			
Sand	1,876	\$2,337	\$1.25
Gravel	3,886	5,721	1.47
Total ¹	5,763	8,057	1.40
Grand total	5,763	8,057	1.40

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

Table 5.—South Dakota: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1976		Value per ton
	Quantity	Value	
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	2,078	\$3,948	\$1.90
Concrete products (cement blocks, bricks, pipe, etc.)	169	359	2.12
Asphaltic concrete aggregates and other bituminous mixtures	785	1,048	1.34
Roadbases and coverings	1,785	2,009	1.13
Fill	892	614	.69
Other uses	53	80	1.51
Total ¹	5,763	8,057	1.40

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

Table 6.—South Dakota: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone total ¹	42	10,268	37	10,653
Crushed and broken:				
Limestone	1,876	3,120	2,228	3,788
Other stone	729	1,962	976	2,799
Total	2,647	15,350	3,241	17,240

^r Revised.

¹ Data represent granite.

Table 7.—South Dakota: Stone sold or used by producers, by use
(Thousand short tons and thousand dollars, unless otherwise specified)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone:				
Rough monumental ¹	229	3,188	207	3,103
Dressed monumental	218	7,080	202	7,550
Total	42	10,268	37	10,653
Crushed and broken stone:				
Bituminous aggregate	234	554	288	713
Concrete aggregate	906	2,190	916	2,341
Macadam aggregate	1	1	W	W
Other construction aggregate and roadstone	121	227	138	271
Surface treatment aggregate	98	192	68	140
Railroad ballast	211	449	328	815
Riprap and jetty stone	23	52	92	232
Other uses ²	1,012	1,416	1,375	2,075
Total ³	2,605	5,082	3,204	6,587
Grand total ³	2,647	15,350	3,241	17,240

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

¹ Includes rough architectural and dressed architectural work.

² Includes stone used for agricultural limestone, dense-graded roadbase stone, cement and lime manufacture and uses not specified or indicated by symbol W.

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

METALS

Gold and Silver.—The Homestake mine at Lead, the sole producer of gold and silver in the State, processed 1.66 million tons of ore in 1976 and recovered 318,500 ounces of gold and 58,100 ounces of silver. Production of gold was up 4%, whereas silver dropped 15% compared with that of the previous year. Total values dipped 19% and 15% for gold and silver, respectively, owing to lower metal prices. During 1976 the average recovery grade of the ore processed was approximately 0.19 ounce per ton in gold content compared with approximately 0.21 ounce per ton in 1975. At midyear Homestake Mining Co. terminated deep-level development activities at its gold mine, owing to unfavorable economic conditions caused by depressed gold prices.

The United Steel Workers Local 7044, AFL-CIO, approved a 3-year contract with Homestake Mining Co. that provided an immediate 6% salary increase and another 6% increase in each of the succeeding 2 years of the contract. Also provided was a gold bonus if the price of gold remains at \$190 for 60 days. The bonus amounted to increments of 14 cents per hour, to a total of 80 cents per hour, for every \$5 increase in the price of gold. The contract expires May 31, 1979.

Iron Ore.—An open pit iron ore property, near the community of Nemo in Lawrence County, was operated by Pete Lien & Sons, Inc., of Rapid City. The entire output was delivered to the State-owned cement plant in Rapid City for use in cement manufacturing.

Table 8.—South Dakota: Mine production (recoverable) of gold and silver

	1974	1975	1976
Mines producing: Lode	1	1	1
Material sold or treated: Gold ore	1,560	1,473	1,658
Production:			
Quantity:			
Gold	343,723	304,935	318,511
Silver	62,474	67,669	58,117
Value:			
Gold	\$54,906	\$49,244	\$39,916
Silver	294	299	253
Total	¹ 55,201	49,543	40,169

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

Table 9.—South Dakota: Homestake mine ore milled and receipts for gold produced

Year	Ore milled (thousand short tons)	Receipts for gold produced	
		Total (thousands)	Per ton
1972	1,467	\$23,875	\$16.27
1973	1,574	34,974	22.22
1974	1,560	54,906	35.20
1975	1,473	49,244	33.43
1976	1,658	39,916	24.07

MINERAL FUELS

Petroleum.—In 1976, production of crude oil decreased 5% in quantity and 8% in value compared with that of the previous year. Output totaling 447,000 barrels was obtained from 43 producing wells throughout 12 fields. The largest

producing field was the Buffalo field, which accounted for 35% of the crude oil production. The Travers Ranch and State Line fields accounted for 26% and 12%, respectively, of the State output.

A total of 44 drilling permits were issued in 1976 and 39 test holes were drilled,

with a total combined footage of 233,511 feet. This compares with 27 permits issued and 27 holes drilled for 144,364 feet in 1975. The deepest hole drilled was 9,771 feet, setting a new depth record in the State, and the shallowest hole was 500 feet. The average depth of all wells was 5,900 feet. Twenty-seven of the tests had as their objective the dolomite of the Red River formation of Ordovician age, a proven reservoir rock in the 10 Harding County oilfields. Five of the holes tested the Minnelusa formation of Pennsylvanian-Permian age, and six holes were drilled to shallower formations such as the Muddy sandstone member of Cretaceous age. One service well was drilled in the Travers Ranch field to dispose of produced field brine in the Minnelusa formation. The drilling success or ratio of producing wells to total wells was 8 to 39 for 21%.

The increased drilling activity during 1976 resulted in one new oil discovery

well and seven field development wells. The discovery well, the Kenneth Luff, Inc., No. 1-19 Dworshak located in SENW 19-23N-6E, is slated to be designated as a new field, East Harding Spring field, by the Board of Natural Resource Development in February 1977. The seven field development wells were drilled in three established fields: One in the Jones Creek field in Harding County; five in the Buffalo field in Harding County; and one in the Lantry field in Dewey County, discovered in 1970, but not established as a field by the Board until 1976. All of the new wells produced from the Red River dolomite of Ordovician age.

Since the year 1900, a total of 816 oil tests have been drilled in the State. Of these wells, 58 have been completed as producing oil wells, of which 43 were still producing at yearend.³

³South Dakota Geological Survey, Western Field Office, Rapid City, S. Dak.

Table 10.—South Dakota: Oil test completions in 1976, by county

County	Total		Status
	Wells	Footage	
Butte -----	2	11,306	Dry and abandoned.
Corson -----	2	15,050	Do.
Dewey -----	1	5,056	Development.
Fall River -----	6	10,977	Dry and abandoned.
Harding -----	19	159,098	1 discovery, 6 development, 1 service, 11 dry and abandoned.
Jackson -----	1	4,871	Dry and abandoned.
Lawrence -----	1	660	Do.
Pennington -----	2	6,932	Do.
Perkins -----	1	6,504	Do.
Todd -----	1	3,395	Do.
Tripp -----	2	4,370	Do.
Ziebach -----	1	5,292	Do.
Total -----	39	233,511	

Source: South Dakota Geological Survey, Western Field Office, Rapid City, S. Dak.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Cement: South Dakota Cement Commission.	Box 360 Rapid City, S. Dak. 57701	Wet-process, 3-rotary-kiln plant.	Pennington.
Clays:			
American Colloid Co -----	Box 160 Belle Fourche, S. Dak. 57717	Open pit mine and plant.	Butte.
Black Hills Clay Products Co.	Box 428 Belle Fourche, S. Dak. 57717	Open pit mine and brick plant.	Do.
Light Aggregates, Inc -----	Box 1922 Rapid City, S. Dak. 57701	Open pit mine and plant.	Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, S. Dak. 57701	Open pit mine ----	Do.
Feldspar: Pacer Corp -----	Box 311 Custer, S. Dak. 57730	Open pit mines and dry-grinding plant.	Custer.
Gold: Homestake Mining Co --	Box 875 Lead, S. Dak. 57754	Underground mine, cyanidation mill and refinery.	Lawrence.
Gypsum: South Dakota Cement Commission.	Box 360 Rapid City, S. Dak. 57701	Open pit mines --	Pennington.
Lime: Pete Lien & Sons, Inc -	Box 3124 Rapid City, S. Dak. 57701	1-rotary-kiln, 1-vertical-kiln, continuous- hydrator plant.	Do.
Sand and gravel (commercial):			
W. E. Bartholow & Sons Construction.	Box 3 Huron, S. Dak. 57350	Pit -----	Various.
Albert Bielke -----	Aberdeen, S. Dak. 57401	Pit and plant -----	Brown.
Birdsall Sand and Gravel Co., Inc.	Box 767 Rapid City, S. Dak. 57701	----do -----	Fall River and Pennington.
Concrete Materials Co ----	100 South Dakota Ave. Sioux Falls, S. Dak. 57102	Pits -----	Minnehaha and Roberts. Pennington.
Duinick Brothers Construction.	Olivia, Minn. 56277 -----	Pit and plant ----	Pennington.
L. G. Everist, Inc -----	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	----do -----	Various.
Fischer Sand and Gravel --	Box 1084 Dickinson, N. Dak. 58601	----do -----	Lawrence.
Fodness Gravel -----	Route 5 Sioux Falls, S. Dak. 57101	----do -----	Minnehaha.
Hallett Construction Co ---	Box 90 St. Peter, Minn. 56082	----do -----	Codington.
Highway Construction Co.--	Box 511 Rapid City, S. Dak. 57701	Pit -----	Pennington.
Mannerud, Inc -----	Box 223 Brookings, S. Dak. 57006	Plant -----	Brookings.
F. J. McLaughlin Co -----	Box 13 Watertown, S. Dak. 57201	Pit -----	Codington.
N&M Construction, Inc --	Box 337 Sturgis, S. Dak. 57785	Pit -----	Meade.
Reynolds Construction Co.--	Box 689 Sioux Falls, S. Dak. 57101	Pits -----	Minnehaha.
Weelborg Brothers, Inc ---	Dell Rapids, S. Dak. 57022--	Pits and mill ----	Various.
Silver: Homestake Mining Co --	Box 875 Lead, S. Dak. 57754	See gold -----	Lawrence.
Stone:			
Cold Spring Granite Co --	Cold Spring, Minn. 56320 --	2 quarries -----	Grant.
Concrete Materials Co ----	100 South Dakota Ave. Sioux Falls, S. Dak. 57102	Quarry and plant -	Minnehaha.
Dakota Granite Co -----	Box 269 Milbank, S. Dak. 57252	2 quarries -----	Grant.
Delano Granite Works, Inc.	Delano, Minn. 55328 -----	Quarry -----	Do.
L. G. Everist, Inc -----	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	Quarry and plant -	Minnehaha and Pennington.
Hills Materials Co -----	Box 1392 Rapid City, S. Dak. 57701	----do -----	Pennington.
Robert Hunter Granite Co., Inc.	501 East Drake St. Milbank, S. Dak. 57252	Quarry -----	Grant.
Pete Lien & Sons, Inc ---	Box 3124 Rapid City, S. Dak. 57701	Quarry and plant -	Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, S. Dak. 57701	----do -----	Do.
Spencer Quarries, Inc ----	Spencer, S. Dak. 57374 ----	Quarry -----	Hanson.
Steiner-Rausch Granite Co.	Route 2, Box 36 Ortonville, Minn. 56278	----do -----	Grant.
Summit-Delzer Joint Venture.	Box 1551 Rapid City, S. Dak. 57701	----do -----	Lawrence.

The Mineral Industry of Tennessee

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Tennessee Division of Geology, for collecting information on all minerals.

By William D. Hardeman ¹

The value of mineral industry production in 1976 was \$440 million, an increase of 4% compared with that of 1975. Tennessee was the leading State in the production of pyrites and ball clay, second in the production of zinc ore, and fourth in the production of phosphate rock. Coal was first in value among the mineral commodities produced in the State during the year, followed by stone and zinc.

Exploration by the mineral industry continued to be active during the year, especially in the search for coal, zinc ore, fluor-spar, oil, and gas. The new Elmwood mine in middle Tennessee attained full production status, and new zinc mines were under development in both middle and eastern Tennessee.

¹ State Liaison Officer, Bureau of Mines, Nashville, Tenn.

Table 1.—Mineral production in Tennessee ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite -----thousand short tons..	13	\$260	W	W
Cement:				
Masonry -----do.....	138	4,778	175	\$6,476
Portland -----do.....	1,136	37,866	1,256	43,495
Clays ² -----do.....	1,310	9,008	1,530	11,578
Coal (bituminous) -----do.....	8,206	140,293	9,233	151,372
Copper (recoverable content of ores, etc.)				
short tons.....	10,041	12,893	11,131	15,494
Lime -----thousand short tons..	106	3,785	W	W
Natural gas -----million cubic feet..	27	12	47	24
Petroleum (crude)				
thousand 42-gallon barrels..	682	7,849	598	8,203
Phosphate rock -----thousand short tons..	2,291	28,803	1,801	14,527
Sand and gravel -----do.....	10,909	22,102	11,096	25,129
Silver (recoverable content of ores, etc.)				
thousand troy ounces.....	54	238	78	339
Stone -----thousand short tons..	^r 38,439	^r 81,187	37,600	86,156
Zinc (recoverable content of ores, etc.)				
short tons.....	83,293	64,968	82,512	61,059
Value of items that cannot be disclosed:				
Clays (bentonite and fuller's earth), gold, pyrites, and values indicated by symbol W_	XX	8,526	XX	15,862
Total	XX	^r 422,518	XX	439,714
Total 1967 constant dollars	XX	167,190	XX	^p 158,077

^p Preliminary. ^r Revised. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes bentonite and fuller's earth; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Tennessee, by county^{1 2}
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Anderson	W	W	Coal, stone, sand and gravel.
Bedford	W	W	Stone.
Benton	W	W	Sand and grave., stone.
Bledsoe	W	W	Coal.
Blount	W	\$2,114	Stone.
Bradley	\$1,252	W	Do.
Campbell	W	W	Coal, stone, sand and gravel, petroleum.
Cannon	W	W	Stone.
Carroll	W	1,110	Clays, sand and gravel.
Carter	W	W	Stone.
Claiborne	W	W	Coal, stone, petroleum.
Clay	W	W	Stone, petroleum.
Cocke	248	169	Stone.
Coffee	W	W	Sand and gravel, stone.
Cumberland	3,537	W	Stone, coal, sand and gravel.
Davidson	W	W	Stone, cement, clays.
Decatur	W	W	Stone, sand and gravel.
De Kalb	W	W	Stone.
Dickson	W	W	Do.
Dyer	W	374	Sand and gravel.
Fayette	34	47	Do.
Fentress	W	9,161	Coal, stone, petroleum, natural gas.
Franklin	W	W	Cement, stone, sand and gravel, clays.
Gibson	W	W	Clays.
Giles	W	W	Phosphate rock, stone.
Grainger	W	W	Stone.
Greene	W	W	Stone, sand and gravel.
Grundy	2,070	W	Coal, stone.
Hamblen	W	W	Stone.
Hamilton	16,988	20,701	Cement, stone, sand and gravel, clays.
Hardeman	247	281	Sand and gravel.
Hardin	W	W	Stone, sand and gravel.
Hawkins	W	W	Sand and gravel, stone.
Henry	6,073	W	Clays, sand and gravel.
Hickman	W	W	Phosphate rock.
Houston	W	W	Sand and gravel.
Humphreys	W	W	Sand and gravel, stone.
Jackson	W	W	Stone, petroleum.
Jefferson	W	39,282	Zinc, stone.
Johnson	W	W	Stone.
Knox	29,164	26,834	Zinc, cement, stone, lime, sand and gravel, clays.
Lauderdale	160	81	Sand and gravel.
Lawrence	W	W	Stone, sand and gravel.
Lincoln	W	W	Stone.
Loudon	W	W	Barite, sand and gravel, stone.
McMinn	W	W	Lime, stone, sand and gravel.
McNairy	W	W	Sand and gravel.
Macon	W	W	Stone.
Madison	102	95	Sand and gravel.
Marion	W	W	Coal, cement, stone, sand and gravel.
Marshall	W	W	Stone.
Maury	W	W	Phosphate rock, stone.
Meigs	W	W	Stone.
Monroe	W	W	Do.
Montgomery	W	W	Do.
Moore	W	182	Do.
Morgan	W	W	Coal, petroleum, natural gas.
Obion	289	279	Sand and gravel.
Overton	1,075	1,135	Coal, stone, petroleum, clays.
Perry	W	W	Sand and gravel.
Pickett	W	W	Stone, petroleum.
Polk	21,455	27,134	Copper, pyrites, zinc, silver, gold.
Putnam	W	W	Coal, stone, sand and gravel.
Rhea	W	W	Stone.
Roane	W	W	Stone, coal, sand and gravel.
Robertson	W	W	Stone, petroleum.
Rutherford	1,347	2,587	Stone.
Scott	W	W	Coal, petroleum, natural gas.
Sequatchie	W	W	Coal, stone.
Sevier	W	W	Stone, sand and gravel.
Shelby	7,636	7,223	Sand and gravel.
Smith	W	W	Zinc, stone.
Stewart	W	W	Stone.
Sullivan	W	W	Cement, stone, clays.
Sumner	W	W	Stone.
Tipton	338	582	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Tennessee, by county^{1 2}—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Unicoi -----	W	W	Sand and gravel, stone.
Union -----	\$1,846	\$3,431	Stone, sand and gravel.
Van Buren -----	419	W	Coal, stone.
Warren -----	W	W	Stone, petroleum.
Washington -----	W	W	Stone, clays, sand and gravel.
Wayne -----	W	148	Sand and gravel.
Weakley -----	4,695	6,458	Clays.
White -----	W	W	Stone.
Williamson -----	W	W	Phosphate rock, stone.
Wilson -----	W	W	Stone.
Undistributed ³ -----	† 323,553	290,307	
Total ⁴ -----	† 422,518	439,714	

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² The following counties are not listed because no production was reported: Cheatham, Chester, Crockett, Hancock, Haywood, Henderson, Lake, Lewis, and Trousdale.

³ The values of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

⁴ Includes some sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

⁵ Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Tennessee business activity

	1975	1976 [†]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands..	1,812.0	1,826.0	+0.8
Unemployment ----- do.....	151.0	110.0	-27.2
Employment (nonagricultural):			
Mining ----- do.....	9.5	9.4	-1.1
Manufacturing ----- do.....	459.0	487.2	+6.1
Contract construction ----- do.....	76.0	75.2	-1.1
Transportation and public utilities ----- do.....	70.8	73.3	+3.5
Wholesale and retail trade ----- do.....	320.8	339.8	+5.9
Finance, insurance, real estate ----- do.....	68.9	69.8	+1.3
Services ----- do.....	229.4	240.0	+4.6
Government ----- do.....	271.3	282.7	+4.2
Total nonagricultural employment ----- do.....	1,505.7	1,577.4	+4.8
Personal income:			
Total ----- millions..	\$20,221	\$22,606	+11.8
Per capita ----- do.....	\$4,846	\$5,364	+10.7
Construction activity:			
Number of private and public residential units authorized -----	14,484	19,136	+32.1
Value of nonresidential construction ----- millions..	\$268.0	\$347.5	+29.7
Value of State road contract awards ----- do.....	\$141.8	\$237.1	+67.2
Shipments of portland and masonry cement to and within the State ----- thousand short tons..	1,479	1,481	+1
Mineral production value:			
Total crude mineral value ----- millions..	† 422.5	\$439.7	+4.1
Value per capita, resident population -----	\$101	\$104	+3.0
Value per square mile -----	\$10,002	\$10,409	+4.1

[†] Preliminary. † Revised.

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

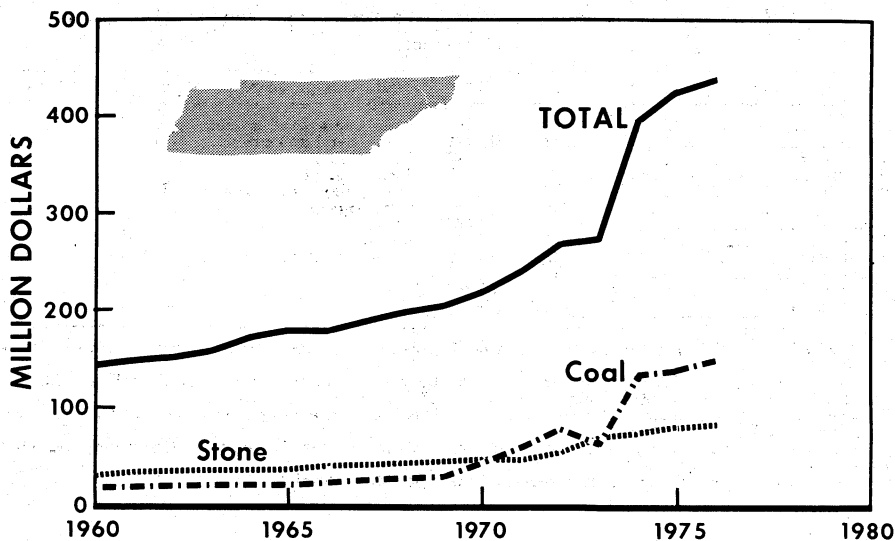


Figure 1.—Value of stone, coal, and total value of mineral production in Tennessee.

About 750 producing mines operated during the year; coal mines were the most numerous, with about 400 companies operating mines at some time during the year. The stone and sand and gravel industries each operated about 100 mines. There were 48 active clay pits and 44 phosphate rock surface mines. Ten large underground mines operated during the year, 7 producing zinc ore and 3, copper ore.²

Legislation and Government Programs.—The Tennessee Division of Geology continued its statewide program of quadrangle geologic mapping and mineral resources investigations in cooperation with the Tennessee Valley Authority (TVA). In addition, the Division continued its broad program of basic and applied research, which included grants from the Federal Bureau of Mines and the U.S. Energy Research and Development Administration (ERDA).

The Geologic Services Branch, TVA, continued its program of airborne magnetic surveying, covering an additional 6,300 square miles in the middle and western parts of the State. Sixteen magnetic anomaly maps prepared by TVA were released by the Tennessee Division of Geology under the cooperative program. Each of these

maps covers about 470 square miles. Cataloging of mineral information in the U.S. Geological Survey (USGS) Computer Resources Information Bank (CRIB) system continued. To date, 3,800 mineral records have been entered into the system by TVA.

In addition, the Geologic Services Branch engaged in a wide variety of engineering geology investigations relating to the location of steam plants, multipurpose dams, and pumped storage reservoirs. Major projects under construction included the Tellico Dam, Columbia Dam, Racoon Mountain pumped storage reservoir and plant, Sequoyah nuclear plant, and Watts Bar nuclear plant.

USGS was engaged in a cooperative program of geological and topographic mapping with the Tennessee Division of Geology. USGS was also investigating water resources under cooperative agreements with several State agencies.

The Tennessee Division of Surface Mining continued its regulation of surface mining operations and the reclamation of lands disturbed by such mining. The Division issued 304 permits covering 8,813 acres for surface mining during the year.

² Directory of Tennessee Mining, Oil & Gas Operations 1976.

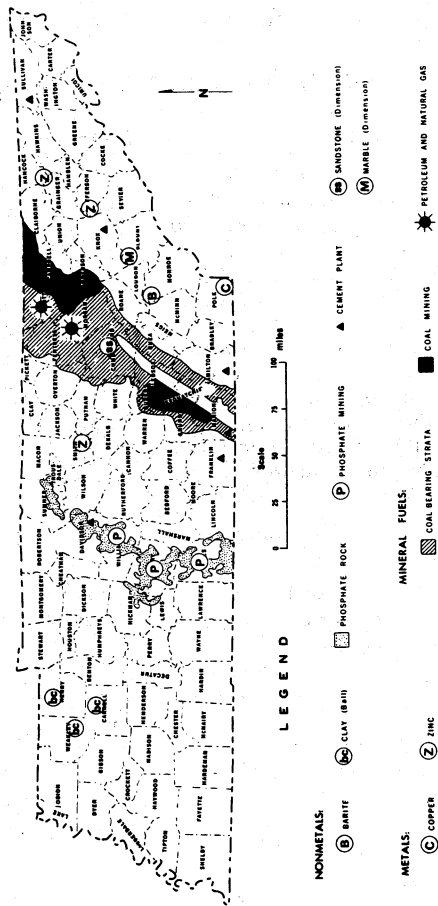


Figure 2.—Generalized map of selected mining areas and industries in Tennessee.

The Division of Mines, Tennessee Department of Labor, operated out of a Knoxville office in carrying out its mine inspection responsibilities under the State mining law.

Tennessee levies a coal severance tax of

20 cents per ton of coal mined; reports and payments are due the 15th of each month. The State also levies a production tax of 4.2 cents per barrel of crude oil and 5% of the sales price of any gas sold.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Mineral fuels accounted for 36% of the total value of mineral production in 1976, about the same as in 1975. Coal accounted for 95% of the value of fuels produced.

Coal (Bituminous).—Production of coal in 1976 was 9.3 million tons³ valued at \$151.4 million, an increase of 13% in tonnage and 8% in value compared with that of 1975. Coal was the major mineral commodity produced in Tennessee. Production was from approximately 185 mining operations in 15 counties of the Cumberland Plateau and Cumberland Mountain regions

of the east-central part of the State. Anderson, Campbell, Claiborne, and Scott were the leading producing counties. As in the preceding year, surface and auger mines accounted for about 52% of the total production and underground mines, for 48%. Most of the surface mines were small producers. The State issued 212 surface mining permits during the year and 112 annual licenses for underground mines.

³ The Bureau collects production data on a voluntary basis. Many small operations did not comply with the Bureau's request for production data and, as in prior years, the figure shown is somewhat less than the amount of coal actually produced in 1976.

Table 4.—Tennessee: Bituminous coal production in 1976, by type of mine and county
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Quantity (thousand short tons)		Value (thousands)
	Under-ground	Surface	Under-ground	Surface	
Anderson -----	23	7	1,524	545	\$32,112
Bledsoe -----	1	4	W	W	W
Campbell -----	19	21	441	1,245	28,571
Claiborne -----	3	5	W	W	W
Cumberland -----	2	1	W	W	W
Fentress -----	1	11	W	W	8,431
Grundey -----	1	2	W	W	W
Marion -----	7	7	436	84	8,514
Morgan -----	2	14	W	W	10,927
Overton -----	1	1	W	W	W
Putnam -----	1	--	W	--	W
Roane -----	--	1	--	W	W
Scott -----	8	31	322	974	19,633
Sequatchie -----	6	2	W	W	W
Van Buren -----	--	3	--	W	W
Undistributed -----	--	--	1,705	2,007	42,744
Total -----	75	110	4,428	4,855	151,372

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

Coke.—The Chattanooga Coke and Chemical Co., Inc., (The Mead Corp.) produced all of the State's coke and breeze at its plant at Alton Park in Hamilton County. Other commodities produced were ammonium sulfate, crude coal tar, and crude light oil.

Nuclear Fuel.—Nuclear Fuel Services, Inc., at Erwin, engages in specialty and developmental work relating to nuclear fuels. Nuclear Fuel Services is a division of Getty Oil Co.⁴

Petroleum and Natural Gas.⁵—Reported oil and gas wells drilled totaled 215, up from those of 1975. The number of exploration wells was up about 15%, while development drilling decreased about 17%. Success ratios for exploratory and development drilling were virtually the same as in 1975. Drilling concentrated in Morgan, Scott, and Fentress Counties.

Crude oil production was 598,430 barrels, a decline of 12% from that of 1975. Wells in Morgan and Scott Counties produced 93% of the total. The discovery of the Lick Branch field was the most significant find since the Indian Creek discovery in late 1973. By yearend, 13 wells in the new field had been completed in the Fort Payne pay with a combined production of 129,204 barrels. Development continued at the Burrville field in Morgan County, which produced 124,145 barrels from 39 Fort Payne wells. A discovery late in the year at Low Gap, also in Morgan County, was promising.

Sales of natural gas were insignificant, only 47 million cubic feet. However, there were 34 gas discoveries during the year, most of which were shut in.

⁴ Getty Oil Co. 1976 Annual Report, P. 36.

⁵ Statler, A. T. Amer. Assoc. of Pet. Geol. Bull., August 1977, pp. 1184-1185.

Table 5.—Tennessee: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Wells	Footage
	Oil	Gas	Dry	Oil	Gas	Dry		
Anderson	--	--	--	1	1	--	2	6,396
Bledsoe	--	--	--	--	--	1	1	1,781
Campbell	--	--	1	1	--	--	2	2,819
Claiborne	1	--	--	--	--	--	1	3,243
Clay	--	--	1	--	--	6	7	7,812
Cumberland	--	--	--	--	--	8	8	15,051
Fentress	2	--	1	1	4	29	37	59,602
Franklin	--	--	--	--	--	3	3	4,295
Greene	--	--	--	--	--	1	1	2,011
Grundy	--	--	--	--	--	3	3	6,086
Jackson	--	--	--	--	--	3	3	2,760
Jackson	--	--	--	4	--	--	65	107,478
Morgan	13	1	9	1	17	21	8	13,986
Overton	--	--	--	1	1	6	8	13,986
Pickett	--	--	--	3	2	5	10	16,201
Rhea	--	--	--	--	1	6	7	13,173
Scott	14	3	4	6	8	20	55	92,622
Van Buren	--	--	--	--	--	1	1	1,432
White	--	--	--	--	--	1	1	1,404
Total	30	4	16	17	34	114	215	358,102

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

NONMETALS

Nonmetals accounted for 46% of the total value of mineral production in 1976. The principal nonmetallic commodities, in order of value, were stone, cement, sand and gravel, clays, and phosphate rock.

Barite.—The C. R. Wood Co., Inc., operated two open pit mines and a concentration plant in Loudon County near Sweetwater. Production was shipped to out-of-State purchasers and was used principally as ground barite in paint and drilling mud. Production decreased compared with that of 1975.

Cement.—Cement was produced by four companies operating six plants in the State—General Portland, Inc., at Chattanooga; Ideal Basic Industries, Inc., at Knoxville; Marquette Co. at Nashville and Cowan; and Penn-Dixie Industries, Inc., at Kingsport and Richard City. Production and shipments of portland cement increased in quantity and about 15% in value over those of 1975. Production of masonry cement also increased significantly in quantity, and the value of shipments rose about 36% above that of 1975.

Types of portland cement shipped included types I and II (general use and moderate heat), type III (high early-strength), waterproof, and expansive. Ready-mix companies were by far the largest purchasers of portland cement; other important customers were concrete product manufacturers, building materials dealers, Government agencies, and highway contractors.

The raw materials used in producing the portland cement were limestone, clay, shale, sand, iron ore, fly ash, and gypsum.

In September 1976, Gulf + Western Industries, Inc., acquired the Marquette Co. in an exchange of stock valued at approximately \$50 million. Marquette is headquartered in Nashville and has 11 production facilities in the United States, with a combined capacity of about 4 million tons of cement per year.⁶

Ideal Basic Industries completed the installation of a new raw mill and two new finish mills in its Knoxville plant at a cost of almost \$20 million. A third and final phase of the modernization program is scheduled for completion in 1979. This will include a new dry-process kiln to replace four old wet-process kilns. The new

Table 6.—Tennessee: Portland cement salient statistics

	(Short tons)	
	1975	1976
Number of active plants	6	6
Production	1,197,907	1,288,952
Shipments from mills:		
Quantity	1,136,403	1,256,210
Value	\$37,865,945	\$43,495,480
Stocks at mills, Dec. 31	111,903	152,271

Table 7.—Tennessee: Masonry cement salient statistics

	(Short tons)	
	1975	1976
Number of active plants	5	5
Production	154,353	194,957
Shipments from mills:		
Quantity	138,386	175,104
Value	\$4,778,473	\$6,476,048
Stocks at mills, Dec. 31	14,954	21,937

kiln will cost an estimated \$28 million and will have a capacity of 580,000 tons per year.⁷

Clays.—Tennessee ranked first in the Nation in the production of ball clay in 1976, producing 64% of the U.S. total. Production of ball clay totaled 513,745 tons valued at \$9,996,374, an increase in tonnage of 21% and in value of 27% over the 1975 figures. Common clay and shale production was 1,015,924 tons valued at \$1,581,536, an increase in tonnage of 15% and in value of 36% over that of the previous year. Production of fuller's earth increased about 7% in both tonnage and value.

Ball clay was mined from 27 open pit operations in Carroll, Gibson, Henry, and Weakley Counties. The major producing companies were Kentucky-Tennessee Clay Co., H. C. Spinks Clay Co., Inc., and Cyprus Industrial Minerals Co. Other producers were NL Industries, Inc., and Old Hickory Clay Co. The principal uses for the ball clay were in the manufacture of pottery, floor and wall tile, sanitary ware, china dinnerware, catalysts (oil refining), ceramics, and electrical porcelain. Other important uses included refractory mortar and

⁶ Gulf + Western Industries, Inc. 1976 Annual Report. P. 20.

⁷ Ideal Basic Industries Inc. 1976 Annual Report. P. 7.

cement, fire brick and block, aluminum refining, crockery and earthenware, asphalt tile, kiln furniture, common brick, flower pots, and quarry tile.

Common clay and shale was produced from 20 open pits by 12 companies. General Shale Corp. was the largest producer, operating five mines in four counties. Other

important producers were Tennlite, Inc.; W. G. Bush and Co.; General Portland, Inc.; Shalite Corp.; and Marquette Co.

Fuller's earth was mined by Lowe's, Inc., in Henry County. H. C. Spinks mined a minor amount of bentonite from an operation in Henry County.

Table 8.—Tennessee: Ball clay sold or used by producers, by kind and use
(Short tons)

Use	1975			1976		
	Airfloat	Unprocessed	Total	Airfloat	Unprocessed	Total
Fine china—						
dinnerware -----	15,520	1,265	16,785	31,749	--	31,749
Electrical porcelain -	W	W	35,551	W	W	14,320
Floor and wall tile,						
ceramic -----	W	W	92,232	W	W	71,421
Glazes, glass, enamel-	457	--	457	496	--	496
Pottery -----	74,260	5,458	79,718	W	W	191,855
Sanitary ware -----	14,768	64,052	78,820	W	W	68,993
Other uses ¹ -----	99,137	88,800	^a 60,154	211,532	201,863	^a 66,806
Exports -----	58,845	1,787	60,632	52,000	16,105	68,105
Total -----	262,987	161,357	424,344	295,777	217,968	513,745

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

¹ Includes asphalt emulsion (1976), adhesives, animal feed (1975), crockery and other earthenware, drilling mud (1975), fertilizers (1976), ceramic hobbyware (1975), firebrick, block and shapes, flower pots (1976), high alumina refractories, kiln furniture, mortar and cement, mineral wool and insulation (1976), oil and grease absorbents (1976), paint (1975), pesticides and related products, rubber, asphalt and quarry tile, waterproofing and sealing (1976), and data indicated by symbol W.

^a Incomplete total; remainder included in individual totals.

Table 9.—Tennessee: Common clay sold or used by producers, by use
(Short tons)

Use	1975	1976
Brick -----	480,172	580,444
Portland cement -----	200,829	199,530
Concrete block -----	204,936	232,650
Structural concrete -----		
Total -----	885,937	1,015,924

Table 10.—Tennessee: Production of clay and shale

Year and type	Quantity (short tons)	Value	
		Total	Average per ton
1975:			
Ball clay -----	424,344	\$7,849,303	\$18.50
Common clay and shale -----	885,937	1,159,053	1.31
Total -----	1,310,281	9,008,356	XX
1976:			
Ball clay -----	513,745	9,996,374	19.46
Common clay and shale -----	1,015,924	1,581,536	1.56
Total -----	1,529,669	11,577,910	XX

XX Not applicable.

Fluorspar.—U.S. Borax and Chemical Co. continued exploration and evaluation of its potentially economic fluorspar deposits in McMinn, Monroe, and Loudon Counties in the Sweetwater district of eastern Tennessee. Several core drills were in operation during the year.

Graphite.—Synthetic graphite was produced from petroleum coke by Union Carbide Corp. at its plant near Columbia in Maury County. The chief use of the graphite produced was in the manufacture of electric furnace electrodes.

Lime.—Two companies produced quick and hydrated lime at plants in eastern Tennessee. Williams Lime Manufacturing Co. operated a plant at Knoxville in Knox County, and Bowaters Southern Paper Corp. operated a plant in McMinn County near Chattanooga. The lime produced had a variety of uses, the principal ones being in pulp and paper processing, water purification, and lithium manufacturing. Production was somewhat below the 1975 figure because the Tennessee Lime Co., which had operated for 40 years, ceased operations in late 1975.

Perlite.—Perlite was produced by Chemrock Corp. at its Nashville plant. The product was used in horticultural and agricultural aggregates, construction aggregates, as insulation, and as a filter aid.

Phosphate Rock.—Tennessee ranked fourth in the Nation in tonnage and value of phosphate rock production in 1976. Surface mining produced phosphate rock in four counties in the Columbia-Mt. Pleasant district of south-central Tennessee. In order of tonnage produced and value, these

counties were Maury, Williamson, Hickman, and Giles. The major producers were Monsanto Industrial Chemical Co., Hooker Chemicals and Plastics Corp. (a subsidiary of Occidental Petroleum Corp.), and Stauffer Chemical Co. M. C. West, Inc., and TVA also operated mines in the area.

Marketable production for the year totaled 1,800,756 tons of concentrate from a mine output of 3,332,453. This marketable production was about 490,000 tons less than the 1975 figure, a decrease of about 21%. Furthermore, the average price of the marketable output, as reported by the companies, dropped from \$12.57 per ton in 1975 to \$8.07 per ton in 1976. This combination of reduced production and lower unit value resulted in a total marketable production value in 1976 of only \$14,527,000 compared with the 1975 value of \$28,803,000, a decrease of nearly 50%.

The average grade of the ore mined was about 20% P_2O_5 . All of the Tennessee production was reduced to elemental phosphorus in the electric furnaces of the major producers. The elemental phosphorus, in turn, was converted into a wide variety of industrial chemicals.

The grade of the marketable rock sold or used during the year, compared with previous year was as follows:

Grade, BPL content ¹	Percent distribution		
	1974	1975	1976
Less than 60% -----	19.7	80.9	72.1
60%-66% -----	75.6	17.5	26.8
66%-70% -----	4.7	1.6	1.1

¹ 1.0% BPL (bone phosphate of lime) = 0.458% P_2O_5 .

Table 11.—Tennessee: Production of phosphate rock

(Thousand short tons and thousand dollars)

Year	Mine production		Marketable production		Value, marketable production	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Total	Average per ton
1972 -----	3,824	817	2,154	583	10,732	\$4.98
1973 -----	4,168	894	2,512	653	12,799	5.10
1974 -----	4,135	821	2,411	648	18,465	7.66
1975 -----	4,052	808	2,291	588	28,803	12.57
1976 -----	3,332	681	1,801	464	14,527	8.07

Table 12.—Tennessee: Phosphate rock sold or used by producers
(Thousand short tons and thousand dollars)

Year	Rock	P ₂ O ₅ content	Value	
			Total	Average per ton
1972	2,240	587	11,188	\$4.99
1973	2,665	699	13,812	5.18
1974	2,607	708	20,594	7.90
1975	2,393	617	29,921	12.50
1976	1,908	494	15,326	8.03

Pyrite.—Tennessee was the Nation's leading producer of pyrite in 1976. Production increased 20% compared with that of 1975. The only producer was Cities Service Co. at its Copperhill operations, where pyrite was recovered by flotation from sulfide ore mined from the company's four underground operations. Processing of sulfide concentrates yielded industrial chemicals (mostly sulfuric acid) and iron sinter.

Sand and Gravel.—Production of sand and gravel increased in both quantity and

value compared with that of 1975. Ninety-three open pit mines were operated in 37 counties scattered throughout the State. Western Tennessee was, however, the most important producing area.

Shelby County, with 18 mines, continued to be the most important producing area, supplying about 38% of the total sand and gravel sold or used during the year. Benton County, with five mines, supplied about 12% of the tonnage produced, mainly for glass and other industrial sand uses.

Table 13.—Tennessee: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quan- tity	Value	Number of mines	Quan- tity	Value
Anderson	1	20	30	1	60	150
Benton	4	W	W	5	1,360	3,837
Carroll	—	—	—	1	(¹)	1
Coffee	3	635	1,454	2	392	W
Cumberland	3	26	83	2	W	W
Davidson	1	W	6	—	—	—
Dyer	2	W	W	3	265	374
Fayette	3	69	34	3	71	47
Franklin	1	86	800	1	W	W
Hardeman	3	212	247	3	193	281
Henry	3	140	104	2	W	W
Humphreys	2	356	W	1	W	W
Lauderdale	6	147	160	6	77	81
Lawrence	1	17	5	1	15	11
McNairy	1	81	W	1	W	W
Madison	3	86	102	3	75	95
Marion	1	W	5	1	16	48
Obion	5	274	289	5	209	279
Perry	2	518	W	2	W	W
Shelby	19	4,416	7,636	18	4,249	7,228
Tipton	7	262	338	6	393	582
Union	1	70	140	1	70	140
Wayne	1	W	W	1	W	148
Other counties ²	23	3,494	10,674	24	3,647	11,831
Total ³	96	10,909	22,102	93	11,096	25,129

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

¹ Less than ½ unit.

² Includes Campbell, Decatur, Greene, Hamilton, Hardin, Hawkins, Houston (1976), Knox, Loudon, McMinn, Putnam, Roane, Sevier, Unicoi, and Washington Counties.

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

Table 14.—Tennessee: Sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	5,533	\$10,673	\$1.93
Gravel	4,678	9,465	2.02
Total	10,211	20,138	1.97
Industrial sand	885	4,991	5.64
Grand total	11,096	25,129	2.26

Table 15.—Tennessee: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)	3,512	\$7,250	\$2.06
Concrete products (cement blocks, bricks, pipe, etc.)	1,590	3,862	2.43
Asphaltic concrete aggregates and other bitumi- nous mixtures	1,331	2,680	2.01
Roadbase and coverings	3,056	5,185	1.70
Fill	541	705	1.30
Other uses	182	456	2.51
Total	¹ 10,211	20,138	1.97

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

Silicon Carbide.—The Carborundum Co. produced silicon carbide at its Jacksboro plant in Campbell County. The product was used for abrasives, refractories, and metallurgical applications.

Stone.—Production of all types of stone in 1976 was 37.6 million tons valued at

\$86.2 million, a decrease in quantity but an increase in value compared with the revised 1975 figures of 38.4 million tons valued at \$81.2 million. Stone was the second leading mineral commodity produced in the State in 1976, surpassed only by bituminous coal.

Table 16.—Tennessee: Stone sold or used by producers in 1976, by type

Type	Quarries	1976		
		Quantity (thousand short tons)	Value (thousands)	Value per ton
Dimension	9	19	\$2,328	\$122.53
Crushed and broken	126	37,581	83,828	2.23
Total	135	37,600	86,156	XX

XX Not applicable.

Crushed stone continued to be the major product, accounting for more than 99% of the tonnage and 97% of the value. Crushed stone was produced from 126 quarries located in central and eastern Tennessee. A very small amount of byproduct crushed stone was produced at dimension stone operations. Vulcan Materials Co. (Mid-South) was the largest producer (21 quarries), followed by ASARCO Incorporated (6 operations), Ralph Rogers Co., Inc. (6 quarries), The Stone Man, Inc. (4 quarries), and Hoover, Inc. (2 quarries). Major end uses for the stone, in descending order

of tonnage used, were dense-graded road-base stone, roadstone, concrete aggregate, agricultural limestone, bituminous aggregate, macadam aggregate, cement manufacture, and surface treatment aggregate.

Seven companies quarried dimension stone for rough monumental stone, cut stone, rubble, and other uses. Output expanded 25% to 19,470 tons valued at \$2,328,000. Leading producers were Georgia Marble Co. (marble) and Turner Bros. Stone Co. (sandstone). Tennessee ranked third among the States in output of dimension marble.

Table 17.—Tennessee: Crushed limestone¹ sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Campbell -----	4	994	1,850	3	1,236	2,270
Cannon -----	1	132	W	1	71	W
Clay -----	1	W	237	1	W	W
Cocke -----	1	124	248	1	112	169
Cumberland -----	3	W	W	3	797	2,259
Davidson -----	8	4,705	9,130	8	3,747	8,503
De Kalb -----	2	266	W	2	W	W
Fentress -----	2	377	650	2	292	664
Franklin -----	4	985	2,427	4	1,040	2,544
Greene -----	5	413	832	4	368	888
Grundy -----	1	W	198	1	W	W
Jefferson -----	6	2,023	3,988	7	1,995	4,516
Johnson -----	1	245	W	1	W	W
Knox -----	3	2,607	5,497	7	2,783	6,088
McMinn -----	2	423	874	2	W	W
Marion -----	4	1,486	3,007	3	1,227	2,721
Moore -----	--	--	--	1	66	182
Pickett -----	--	--	--	1	34	84
Putnam -----	2	W	W	3	525	1,243
Rutherford -----	3	702	1,347	3	1,138	2,587
Smith -----	2	192	W	1	W	W
Union -----	1	130	208	1	169	279
Union -----	3	532	1,706	3	459	1,850
Van Buren -----	--	--	--	1	200	300
Washington -----	5	221	377	5	242	415
Undistributed ² -----	63	21,859	46,414	57	21,074	46,220
Total ³ -----	132	38,415	79,039	126	37,574	83,677

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Includes dolomite.

³ Includes Anderson, Bedford, Benton, Blount, Bradley, Carter, Claiborne, Coffee, Decatur, Dickson, Giles, Hamblen, Hamilton, Hardin, Hawkins, Humphreys, Jackson, Lawrence, Lincoln, Loudon (1975), Macon, Marshall, Maury, Meigs, Monroe, Montgomery, Overton, Rhea, Roane, Robertson, Sequatchie, Sevier, Stewart, Sullivan, Sumner, Warren, White, Williamson, and Wilson Counties.

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

Table 18.—Tennessee: Crushed limestone¹ sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	12,118	24,168	12,170	26,440
Roadstone -----	7,208	14,800	6,571	14,290
Concrete aggregate -----	^r 7,009	^r 14,092	5,619	12,060
Agricultural limestone -----	2,286	4,774	2,936	6,864
Bituminous aggregate -----	2,347	4,771	2,453	5,205
Macadam aggregate -----	2,088	4,272	2,433	5,401
Cement manufacture -----	1,811	3,692	1,815	4,153
Surface treatment aggregate -----	1,434	2,991	1,440	3,261
Riprap and jetty stone -----	634	1,328	594	1,262
Other uses ² -----	^r 1,482	^r 4,150	1,544	4,745
Total ³ -----	^r 38,415	^r 79,039	37,574	83,677

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

¹ Includes limestone, marble, and sandstone.

² Includes glass, lime manufacture, whiting (1976), mine dusting, filter stone, asphalt filler, other fillers, terrazzo and exposed aggregate, flux stone (1975), refractory stone (1975), mineral foods, railroad ballast, drain fields, unspecified uses, and uses indicated by symbol W.

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

Table 19.—Tennessee: Production of dimension stone,¹ by use

Use	1975			1976		
	Quantity		Value (thousands)	Quantity		Value (thousands)
	Short tons	Cubic feet		Short tons	Cubic feet	
Rubble -----	2,267	29,060	W	2,617	33,240	\$90
Irregular-shaped stone -----	519	6,663	\$7	2,569	32,860	86
Rough blocks -----	5,514	63,760	145	W	W	W
House stone veneer -----	1,487	19,060	50	1,690	21,670	54
Sawed stone -----	1,362	14,860	288	1,404	15,510	247
Dressed flagging -----	69	885	11	54	700	9
Other uses ² -----	4,320	52,760	1,497	11,140	128,600	1,841
Total ³ -----	15,538	187,060	1,998	19,474	232,570	2,328

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

¹ Includes marble and sandstone.

² Includes stone used as rough monumental (1976), cut stone, rough flagging, dressed monumental (1975), unspecified uses, and uses indicated by symbol W.

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

Sulfuric Acid.—Sulfuric acid was produced by Cities Service Co. from sulfur gases generated during the roasting and smelting of pyrite and copper concentrates at the company's Copperhill operations. Sulfuric acid was the most important chemical product from these operations.

Vermiculite.—Construction Products Div., W. R. Grace & Co., continued production of expanded crude vermiculite at its plant in Nashville. The product was used in block insulation, concrete aggregates, horticulture, soil conditioning, plaster aggregates, and loose fill insulation.

METALS

Metals accounted for 17% of the total value of mineral production in 1976. Zinc ore was 79% of the value of metal production and copper accounted for nearly all of the remaining 21%.

Aluminum.—Tennessee ranked second in the Nation in the quantity and value of aluminum metal produced in 1976, increasing 10% compared with 1975 levels. The Aluminum Company of America (Alcoa) in Blount County and Consolidated Aluminum Corp. (Conalco) in Humphreys

County produced aluminum metal from alumina imported from outside the United States.

Copper.—Production of copper metal in 1976 was 11,131 tons valued at about \$15.5 million. This was an increase of about 11% in quantity and about 20% in value compared with 1975 figures.

Cities Service Co. in Polk County was the State's only copper producer. The Copperhill operations of the company included the Boyd, Calloway, and Cherokee underground mines. The London flotation plant separated the ore into copper, pyrite, and zinc concentrates. The copper concen-

trates were further processed by roasting and smelting to produce, in order of value, sulfuric acid, copper metal, and iron sinter. The zinc concentrates produced were sold and shipped out of State.

Modification of iron roasters was almost complete and a revamped sulfuric acid plant went into operation. Continued improvement in iron roaster performance, a satisfactory operation of acid plants, and the addition of a source of open pit ore indicated that earlier problems relating to the continuity of acid supply have been solved.⁸

Table 20.—Tennessee: Mine production (recoverable) of gold, silver, copper, and zinc

	1974	1975	1976
Mines producing: Lode	10	11	10
Material sold or treated:			
Ore:			
Copper-zinc	1,153	1,635	2,034
Zinc	3,093	3,106	3,125
Total	4,246	4,741	5,159
Production:			
Quantity:			
Gold	18	W	W
Silver	20,053	53,752	77,890
Copper	6,304	10,041	11,131
Zinc	85,671	83,293	82,512
Value:			
Gold	\$3	W	W
Silver	94	\$238	\$339
Copper	9,745	12,893	15,494
Zinc	61,512	64,968	61,059
Total	71,854	W	W

W Withheld to avoid disclosing company proprietary data.

Ferroalloys.—Tennessee ranked third in the Nation in quantity and sixth in value of ferroalloys produced in 1976. Six companies produced 195,000 tons valued at \$68,000,000, an increase in tonnage of 16% and in value of 11% compared with that of 1975.

The principal uses of ferroalloys are as additives and alloying elements in the manufacture of carbon steels, stainless steels, other alloy steels, cast irons, and various alloys.

Monsanto Industrial Chemical Co., Stauffer Chemical Co., and Hooker Chemicals and Plastics Corp. produced ferrophosphorous as a byproduct of their electric furnace operations in Maury County. Roane Electric Furnace Co., Inc., a subsidiary of Engelhard Minerals & Chemicals Corp., pro-

duced ferrosilicon, ferromanganese, and silicomanganese in an electric furnace at Rockwood in Roane County. Tennessee Metallurgical Corp., a subsidiary of International Minerals & Chemical Corp., produced ferrosilicon at Kimball in Marion County, and Chromium Mining & Smelting Corp. produced ferrochromium from electric furnace operations at Woodstock in Shelby County.

Gold.—A small amount of gold was produced as a byproduct of refining copper at Cities Service Co.'s Copperhill operations.

Iron.—Iron sinter was produced by Cities Service Co. as a byproduct of the processing of pyrite and copper concen-

⁸ Cities Service Company. 1976 Annual Report. P. 13.

trates at its Copperhill operations in Polk County. The product is sold to the iron and steel industry.

Magnesium Chloride.—Tennessee Die Casting Co. at Ripley continued producing magnesium die castings from metal produced in Texas. The company also produces aluminum and zinc die castings.

Manganese.—Foot Mineral Co. continued production of electrolytic manganese metal at its plant in New Johnsonville. The product was sold primarily to the steel and aluminum industries. Demand was high during most of 1976.

Rare-Earth Metals and Thorium.—W. R. Grace & Co., Davison Chemical Div., processed bastnäsite and imported monazite concentrates for rare earths and thorium at its Chattanooga plant. The company was the only monazite processor in the United States. Thorium was extracted from monazite during the refining of rare-earth elements and stored. The company's stockpile is probably the largest readily available supply of thorium in the United States.

Silver.—Silver was recovered at out-of-State refineries as a byproduct of refining copper concentrates from Cities Service Co.'s Copperhill operations. Production increased from about 54,000 troy ounces valued at \$238,000 in 1975 to about 78,000 troy ounces valued at \$339,000 in 1976.

Titanium.—E.I. duPont de Nemours & Co., Inc., continued production of titanium dioxide pigment using ilmenite and rutile concentrates from Florida, Georgia, New Jersey, and Australia. Capacity of its New Johnsonville plant is 228,000 tons of pigment per year, making it the largest plant of this type in the United States. Waste from the plant consisted of an aqueous solution of ferric chloride with a specific gravity of about 1.3, which is produced at a rate of about 500 gallons per minute. This waste is injected into two deep (5,000 to 6,000 feet) disposal wells.

Zinc.—Tennessee ranked second, slightly behind Missouri, among zinc-producing

States in both quantity and value of zinc ore mined and processed. Production was 82,512 tons of zinc, slightly below that of 1975.

Zinc ore was produced from seven mines—six in eastern Tennessee and one in middle Tennessee. Copper-zinc ore was produced from three mines near Ducktown in southeast Tennessee.

In the Mascot-Jefferson City zinc district, ASARCO Incorporated operated four mines (Coy, Immel, New Market, and Young), United States Steel operated the Davis-Bible mine, and The New Jersey Zinc Co. operated the Jefferson City mine. New Jersey Zinc also had two mines under development in this area, the Beaver Creek and Lost Creek mines.

In the new middle Tennessee zinc district, Jersey Miniere Zinc Co., a joint venture of The New Jersey Zinc Co. (60%) and Union Miniere S.A. of Belgium (40%), operated the Elmwood mine, which attained full production status in 1976. Jersey Miniere continued development of the Gordonsville mine, about 2 miles southwest of the Elmwood, with a projected 9,000-ton-per-day capacity. An additional mine, the Stonewall, was in the planning stage. St. Joe Minerals Corp. formed a joint venture (Carthage Zinc Co.) with Freeport Zinc Co. involving a 3-year, \$5 million exploration and development zinc project near Carthage, north of the Elmwood mine.

In the Ducktown district, the Copperhill operations of Cities Service Co. produced copper-zinc ore from three mines (the Boyd, Calloway, and Cherokee).

Jersey Miniere broke ground for a \$97 million, 90,000-ton-per-year electrolytic zinc refinery near Clarksville; the refinery is scheduled for completion early in 1979. Ore from the company's mines will be transported to the plant by river barge. This will be the first zinc refinery built in the United States since 1941 and will represent a 14% increase in current U.S. production of zinc metal.

Table 21.—Tennessee: Tenor of zinc ore milled and concentrate produced in 1976

Total material	short tons..	3,125,452
Metal content of ore: ¹ Zinc	percent..	2.50
Concentrate produced and average content:		
Zinc	short tons..	136,135
Recovery ratio	percent..	4.36
Average zinc content	do.....	63.05

¹ Figure represents metal content of crude ore only as contained in the concentrate.

Table 22.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum smelters:			
Aluminum Company of America.	Box 158 Alcoa, Tenn. 37701	Plant	Blount.
Consolidated Aluminum Corp.	1102 Richmond St. Jackson, Tenn. 38301	do	Humphreys.
Barite:			
C. R. Wood Co., Inc	Box 284 Sweetwater, Tenn. 37874	Open pit mines and mill.	Loudon.
Cement:			
General Portland, Inc	1300 American National Bank Bldg. Chattanooga, Tenn. 37402	Plant	Hamilton.
Ideal Basic Industries, Inc	Box 6238 Knoxville, Tenn. 37914	do	Knox.
Marquette Co	First American Center Nashville, Tenn. 37238	Plants	Davidson.
Penn-Dixie Industries, Inc	60 East 42d St. New York, N.Y. 10017	do	Marion and Sullivan.
Clays:			
Cyprus Industrial Minerals Co.	Box 111 Gleason, Tenn. 38229	Pits and plants	Carroll and Weakley.
Kentucky-Tennessee Clay Co.	Box 449 Mayfield, Ky. 42066	do	Carroll, Gibson, Henry, Weakley.
Lowe's, Inc	Box 819 Paris, Tenn. 38242	do	Henry.
H. C. Spinks Clay Co., Inc.	Box 820 Paris, Tenn. 38242	do	Henry and Weakley.
Coal, bituminous:			
Consolidation Coal Co	Box 460 Middlesboro, Ky. 40965	Underground mine and plant.	Claiborne.
Grundy Mining Co., Inc	Box 878 Jasper, Tenn. 37347	Underground mine.	Marion.
Long Pit Mining Co	Box 443 Harriman, Tenn. 37748	Auger and strip mines.	Campbell.
Oliver Springs Mining Co., Inc.	Box 850 Oliver Springs, Tenn. 37840	Underground mines	Anderson.
Volunteer Mining Corp	Cody, Ky. 41808	do	Do.
Coke:			
The Mead Corp. ¹	4800 Central Ave. Chattanooga, Tenn. 37410	Plant	Hamilton.
Copper:			
Cities Service Co. ²	Copperhill, Tenn. 37317	Underground mines and plant.	Polk.
Ferroalloys:			
Chromium Mining & Smelting Corp.	Box 28538 Memphis, Tenn. 38128	Plant	Shelby.
Hooker Chemicals and Plastics Corp. ¹	Box 591 Columbia, Tenn. 38401	do	Maury.
Monsanto Industrial Chemical Co. ¹	Columbia, Tenn. 38401	do	Do.
Stauffer Chemical Co. ¹	Box 472 Mt. Pleasant, Tenn. 38474	do	Do.
Tennessee Metallurgical Corp.	818 Hamilton Bank Bldg. Chattanooga, Tenn. 37402	do	Marion.
Graphite, synthetic:			
Union Carbide Corp	Box 513 Columbia, Tenn. 38401	do	Maury.
Lime:			
Bowaters Southern Paper Corp.	Calhoun, Tenn. 37809	do	McMinn.
Williams Lime Manufacturing Co.	Box 2286 Knoxville, Tenn. 37901	do	Knox.
Perlite, expanded:			
Chemrock Corp	Osage St. Nashville, Tenn. 37208	do	Davidson.
Petroleum refinery:			
Delta Refinery Co	543 West Mallory Ave. Memphis, Tenn. 38106	do	Shelby.
Phosphate rock:			
Hooker Chemicals and Plastics Corp. ¹	Box 591 Columbia, Tenn. 38401	do	Maury.
Monsanto Industrial Chemical Co. ¹	Columbia, Tenn. 38401	do	Do.
Stauffer Chemical Co. ¹	Box 472 Mt. Pleasant, Tenn. 38474	do	Do.
Tennessee Valley Authority	Box 73 Columbia, Tenn. 38401	Open pit mines and plant.	Maury and Williamson.

See footnotes at end of table.

Table 22.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Camden Gravel Co -----	Box 207 Camden, Tenn. 38320	Pit -----	Benton.
T. L. Herbert & Sons -----	1136 2d Ave. North Nashville, Tenn. 37208	Dredge -----	Houston.
Memphis Stone and Gravel Co.	Box 38269 Germantown, Tenn. 38138	Pits -----	Benton, Dyer, Shelby.
Clyde Owen Sand and Gravel, Inc.	10636 Shelton Rd. Collierville, Tenn. 38017	Pit -----	Shelby.
Standard Construction Co., Inc.	Box 38239 Germantown, Tenn. 38138	Pit -----	Do.
Stone:			
American Limestone Co ---	Box 2389 Knoxville, Tenn. 37901	Quarries -----	Jefferson, Knox, Sullivan.
Mid-South Pavers Inc -----	720 Argyle Ave. Nashville, Tenn. 37203	---do -----	Jackson and Putnam.
The Stone Man, Inc -----	Box 2098 Chattanooga, Tenn. 37409	---do -----	Bedford, Hamilton, Rutherford, Warren.
Vulcan Materials Co -----	Box 7 Knoxville, Tenn. 37901	---do -----	Various.
Webb Stone Co -----	Box 806 Athens, Tenn. 37303	Quarry -----	McMinn.
Vermiculite, exfoliated:			
W. R. Grace & Co -----	4061 Powell Ave. Nashville, Tenn. 37204	Plant -----	Davidson.
Zinc:			
ASARCO Incorporated ³ ---	Mascot, Tenn. 37806 -----	Underground mines and plant.	Jefferson and Knox.
Jersey Miniere Zinc Co ---	Elmwood, Tenn. 38560 -----	Underground mine.	Smith.
The New Jersey Zinc Co --	Box 32 Jefferson City, Tenn. 37760	---do -----	Jefferson.
United States Steel Corp --	Jefferson City, Tenn. 37760	---do -----	Do.

¹ Also ferroalloys.² Also gold, silver, zinc, and pyrites.³ Also silver and stone.

The Mineral Industry of Texas

This chapter has been prepared under a cooperative agreement 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 minerals except fuels.

By Murphy E. Hawkins¹ and Thomas J. Evans²

Texas mineral production, comprised of fuels and metallic and nonmetallic minerals, was valued at \$18,143 million in 1976, an increase of 17% over the output in 1975. This was the 42d consecutive year in which Texas led the Nation in value of mineral production.

Texas continued to rank first in the production of petroleum, natural gas, natural gas liquids, carbon black, natural graphite, magnesium chloride, and sulfur (both recovered and Frasch). The State also ranked among the leaders in the production of cement, clays, gypsum, lime, salt, sand and gravel, stone, talc, and uranium.

A total of 239 of the State's 254 counties yielded commercial mineral production in 1976. Petroleum and natural gas was produced in 210 counties, nonmetallic minerals in 148 counties, metallics in 8 counties, and coal (lignite) in 5 counties.

Legislation and Government Programs.—The Texas Legislature, which

meets biannually, was not in session in 1976. State regulatory agencies, however, adopted rules and regulations that affected the mineral industry, and some of the notable actions are included here.

The Texas Railroad Commission (TRRC) held hearings and promulgated rules and regulations for the Texas Surface Mining and Reclamation Act of 1975 that became effective January 1, 1976. The law covers the surface mining of coal, lignite, and uranium.

The Texas Attorney General ruled that surface mining operations that extract lignite incidental to the production of other minerals are not covered by the Texas Surface Mining and Reclamation Act. The TRRC requested an opinion by the Attorney General because some clay mining operations extracted lignite that overlies the clay.

¹State Liaison Officer, Bureau of Mines, Austin, Tex.

²Geologist, Bureau of Economic Geology, The University of Texas at Austin, Austin, Tex.

Table 1.—Mineral production in Texas ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry ----- thousand short tons	181	\$7,089	213	\$10,596
Portland ----- do	7,195	224,804	7,388	271,066
Clays ----- do	4,248	13,411	^a 3,706	^a 8,847
Coal (lignite) ----- do	11,002	W	14,063	W
Gem stones ----- do	NA	160	NA	168
Gypsum ----- thousand short tons	1,094	4,277	1,531	6,322
Helium, crude ----- million cubic feet	36	432	12	144
Iron ore ----- thousand long tons	601	W	566	W
Lime ----- thousand short tons	1,735	46,179	1,455	43,983
Natural gas ----- million cubic feet	7,485,764	3,885,112	7,191,859	5,163,755
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels	78,835	479,700	77,578	560,831
LP gases ----- do	212,635	965,363	209,514	1,223,562
Petroleum (crude) ----- do	1,221,929	9,336,570	1,189,523	10,217,702
Salt ----- thousand short tons	8,560	42,119	9,718	48,375
Sand and gravel ----- do	38,649	87,106	47,848	103,217
Stone ----- do	57,985	106,554	54,856	101,652
Sulfur (Frasch) ----- thousand long tons	3,406	W	3,415	W
Talc and soapstone ----- short tons	129,626	795	199,663	1,071
Value of items that cannot be disclosed:				
Asphalt (natural), clays (fuller's earth, 1976 and kaolin, 1976), fluorspar, graphite, magnesium chloride, mag- nesium compounds, sodium sulfate, uranium, and values indicated by symbol W -----	XX	^r 325,701	XX	381,413
Total -----	XX	^r 15,525,972	XX	18,143,204
Total 1967 constant dollars -----	XX	6,143,390	XX	^p 6,522,655

^p Preliminary. ^r Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes fuller's earth and kaolin; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Texas, by county ¹

(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Anderson -----	\$159,955	\$160,753	Petroleum, natural gas.
Andrews -----	448,875	487,213	Petroleum, natural gas, natural gas liquids, stone.
Angelina -----	596	525	Natural gas, petroleum.
Aransas -----	17,804	18,870	Natural gas, petroleum, natural gas liquids.
Archer -----	24,992	31,652	Petroleum, natural gas.
Armstrong -----	W	886	Sand and gravel.
Atascosa -----	42,740	53,343	Natural gas, petroleum, natural gas liquids, sand and gravel.
Austin -----	23,607	22,653	Petroleum, natural gas.
Bailey -----	W	W	Stone.
Bastrop -----	1,256	1,104	Petroleum, clays, natural gas.
Baylor -----	W	W	Petroleum, natural gas.
Bee -----	38,675	49,126	Natural gas, petroleum, natural gas liquids.
Bell -----	3,043	3,381	Stone, sand and gravel.
Bexar -----	51,141	57,115	Cement, stone, natural gas liquids, lime, petroleum, sand and gravel, clays, natural gas.
Blanco -----	11	--	
Borden -----	89,239	102,716	Petroleum, natural gas, sand and gravel.
Bosque -----	W	W	Lime, stone.
Bowie -----	1,477	2,962	Natural gas, petroleum, sand and gravel.
Brazoria -----	522,410	605,937	Petroleum, natural gas, magnesium chloride, natural gas liquids, salt, magnesium compounds, stone, sand and gravel, lime.
Brazos -----	2,602	3,207	Sand and gravel, natural gas, petroleum.
Brewster -----	W	W	Fluorspar, sand and gravel, stone.
Brooks -----	98,239	126,936	Natural gas, natural gas liquids, petroleum.
Brown -----	5,771	7,193	Petroleum, natural gas, stone, clays.
Burleson -----	1,128	1,403	Petroleum, natural gas.
Burnet -----	W	W	Stone, graphite.
Caldwell -----	19,052	21,112	Petroleum, natural gas.
Calhoun -----	36,477	39,445	Natural gas, petroleum, natural gas liquids, lime.
Callahan -----	7,231	9,805	Petroleum, natural gas, stone.
Cameron -----	5,950	7,441	Natural gas, petroleum.
Camp -----	8,862	8,668	Petroleum, natural gas, clays.
Carson -----	88,402	112,056	Natural gas, natural gas liquids, petroleum.
Cass -----	43,940	52,211	Natural gas liquids, natural gas, petroleum, iron ore.
Chambers -----	225,807	267,292	Petroleum, natural gas, natural gas liquids, salt, clays, sand and gravel.
Cherokee -----	8,126	8,981	Natural gas liquids, petroleum, natural gas, clays.
Childress -----	156	133	Petroleum, natural gas.
Clay -----	14,636	16,913	Petroleum, natural gas, stone.
Cochran -----	149,633	169,270	Petroleum, natural gas, natural gas liquids.
Coke -----	37,371	43,806	Petroleum, natural gas liquids, natural gas, sand and gravel.
Coleman -----	6,201	9,173	Petroleum, natural gas, clays, stone.
Collin -----	W	W	Stone.
Collingsworth -----	3,392	4,011	Natural gas, petroleum.
Colorado -----	91,447	110,876	Natural gas, natural gas liquids, sand and gravel, petroleum.
Comal -----	W	W	Stone, lime, sand and gravel.
Comanche -----	995	1,469	Natural gas, petroleum, sand and gravel, stone, clays.
Concho -----	2,932	3,669	Petroleum, natural gas, natural gas liquids.
Cooke -----	59,319	57,134	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Coryell -----	W	W	Sand and gravel, stone.
Cottle -----	716	4,670	Natural gas, petroleum.
Crane -----	378,604	439,253	Petroleum, natural gas, natural gas liquids.
Crockett -----	109,833	141,428	Natural gas, petroleum, natural gas liquids, stone.
Crosby -----	2,304	3,121	Sand and gravel, petroleum, stone, natural gas.
Culberson -----	79,594	85,235	Sulfur, petroleum, talc, stone, natural gas.
Dallam -----	W	W	Stone, natural gas.
Dallas -----	W	W	Cement, sand and gravel, stone, clays.
Dawson -----	88,518	101,168	Petroleum, natural gas, natural gas liquids.
Deaf Smith -----	W	W	Lime.
Denton -----	2,093	2,660	Natural gas, sand and gravel, clays, petroleum.
De Witt -----	29,473	37,923	Natural gas, petroleum, natural gas liquids.
Dickens -----	2,540	2,331	Petroleum, stone, natural gas.
Dimmit -----	54,263	58,812	Petroleum, natural gas, natural gas liquids.
Donley -----	W	W	Natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Duval	\$79,077	\$84,835	Petroleum, natural gas, natural gas liquids, salt, sand and gravel, uranium.
Eastland	8,249	11,847	Natural gas, natural gas liquids, petroleum, clays, stone.
Ector	693,458	794,419	Petroleum, natural gas liquids, natural gas, cement, stone.
Edwards	4,672	8,313	Natural gas, natural gas liquids, petroleum.
Ellis	51,535	W	Cement, stone, clays, petroleum, natural gas.
El Paso	W	W	Cement, stone, sand and gravel.
Erath	1,101	1,390	Natural gas, petroleum.
Falls	597	221	Do.
Fannin	W	W	Sand and gravel.
Fayette	3,436	3,965	Clays, petroleum, sand and gravel, natural gas.
Fisher	83,527	83,002	Petroleum, natural gas, natural gas liquids, gypsum, sand and gravel, clays.
Foard	2,168	2,440	Petroleum, natural gas.
Fort Bend	158,401	158,643	Petroleum, natural gas, sulfur, natural gas liquids, salt, sand and gravel, clays.
Franklin	34,103	39,363	Petroleum, natural gas, natural gas liquids.
Freestone	22,647	31,927	Coal, natural gas, petroleum, stone, clays.
Frio	12,826	54,065	Petroleum, natural gas, natural gas liquids.
Gaines	404,674	469,391	Petroleum, natural gas, natural gas liquids, sodium sulfate.
Galveston	115,513	162,829	Natural gas, petroleum, natural gas liquids, sand and gravel, clays.
Garza	52,477	60,795	Petroleum, natural gas.
Gillespie	W	W	Sand and gravel, gypsum, stone.
Glasscock	29,502	43,331	Petroleum, natural gas.
Goliad	20,344	27,586	Natural gas, petroleum.
Gonzales	3,562	3,545	Do.
Gray	78,893	90,534	Petroleum, natural gas, natural gas liquids, sand and gravel.
Grayson	51,434	57,434	Petroleum, natural gas, natural gas liquids, stone.
Gregg	419,308	471,031	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Grimes	224	214	Natural gas, petroleum.
Guadalupe	13,731	14,768	Petroleum, sand and gravel, clays, natural gas.
Hale	59,142	70,102	Petroleum, natural gas liquids, natural gas.
Hall	W	W	Sand and gravel.
Hamilton	567	414	Natural gas, petroleum.
Hansford	44,906	56,310	Natural gas, petroleum, stone.
Hardeman	7,735	7,719	Petroleum, gypsum, natural gas liquids, natural gas.
Hardin	40,304	40,683	Petroleum, natural gas, natural gas liquids.
Harris	420,112	476,742	Petroleum, cement, natural gas liquids, natural gas, salt, sand and gravel, lime, clays.
Harrison	25,925	31,904	Natural gas, petroleum, natural gas liquids, coal, clays, sand and gravel.
Hartley	W	W	Natural gas.
Haskell	19,677	18,647	Petroleum, natural gas, stone.
Hays	1,573	1,169	Sand and gravel.
Hemphill	113,214	143,618	Natural gas, petroleum, natural gas liquids.
Henderson	31,200	36,948	Natural gas liquids, natural gas, petroleum, clays, sand and gravel.
Hidalgo	78,804	107,558	Natural gas, petroleum, natural gas liquids, sand and gravel, stone.
Hill	W	4,604	Lime, stone, petroleum, natural gas.
Hockley	375,152	413,329	Petroleum, natural gas liquids, natural gas.
Hood	W	491	Natural gas, petroleum.
Hopkins	19,311	20,818	Petroleum, natural gas, natural gas liquids, coal.
Houston	17,763	21,488	Natural gas, petroleum, natural gas liquids.
Howard	138,946	162,461	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Hudspeth	1,224	W	Talc, stone, gypsum.
Hunt	361	442	Natural gas, petroleum.
Hutchinson	162,148	206,261	Natural gas liquids, natural gas, petroleum, sand and gravel, salt.
Irion	23,734	31,745	Petroleum, natural gas, natural gas liquids.
Jack	29,282	37,176	Petroleum, natural gas, natural gas liquids, stone.
Jackson	181,100	191,777	Petroleum, natural gas, natural gas liquids.
Jasper	3,359	6,518	Petroleum, natural gas.
Jeff Davis	W	W	
Jefferson	104,133	105,948	Natural gas, petroleum, sulfur, natural gas liquids, salt, sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Jim Hogg -----	\$19,832	\$22,205	Natural gas, petroleum.
Jim Wells -----	168,463	202,596	Natural gas, natural gas liquids, petroleum, stone.
Johnson -----	W	W	Lime, stone, sand and gravel.
Jones -----	14,526	16,101	Petroleum, natural gas, sand and gravel, stone.
Karnes -----	51,137	52,829	Natural gas, petroleum, uranium, natural gas liquids, stone.
Kaufman -----	3,949	3,988	Petroleum, stone, natural gas.
Kenedy -----	50,585	65,003	Natural gas, natural gas liquids, petroleum.
Kent -----	105,800	119,426	Petroleum, natural gas, sand and gravel.
Kerr -----	155	W	Sand and gravel, stone.
Kimble -----	941	1,551	Natural gas, sand and gravel, stone, petroleum.
King -----	26,325	36,946	Petroleum, natural gas.
Kleberg -----	335,730	439,393	Natural gas, natural gas liquids, petroleum.
Knox -----	5,804	7,149	Petroleum, natural gas.
Lamb -----	1,039	W	Petroleum, stone, natural gas.
Lampasas -----	89	127	Sand and gravel, stone.
La Salle -----	3,937	5,488	Natural gas, petroleum.
Lavaca -----	34,383	45,729	Natural gas, petroleum, natural gas liquids.
Lee -----	1,266	1,877	Petroleum, natural gas.
Leon -----	3,941	4,197	Natural gas, petroleum.
Liberty -----	61,899	70,025	Petroleum, sulfur, natural gas, natural gas liquids, sand and gravel.
Limestone -----	9,210	12,193	Clays, natural gas, sand and gravel, petroleum, stone.
Lipscomb -----	28,935	36,201	Natural gas, petroleum.
Live Oak -----	37,218	42,751	Natural gas, petroleum, natural gas liquids, uranium, sand and gravel.
Llano -----	576	W	Stone.
Loving -----	25,249	46,297	Natural gas, petroleum.
Lubbock -----	4,657	5,175	Petroleum, sand and gravel, stone, natural gas, natural gas liquids.
Lynn -----	1,567	1,703	Petroleum, natural gas, stone.
McCulloch -----	5,737	5,342	Sand and gravel, natural gas, petroleum, stone.
McLennan -----	15,222	19,708	Cement, sand and gravel, natural gas liquids, stone, clays, petroleum, natural gas.
McMullen -----	24,855	29,064	Natural gas, petroleum, stone.
Madison -----	6,682	8,793	Natural gas, petroleum.
Marion -----	5,589	7,426	Petroleum, natural gas, clays.
Martin -----	94,771	107,430	Petroleum, natural gas.
Mason -----	W	22	Stone.
Matagorda -----	112,515	140,289	Natural gas, petroleum, natural gas liquids, stone, salt.
Maverick -----	11,994	14,129	Petroleum, natural gas, natural gas liquids, sand and gravel.
Medina -----	2,085	2,837	Petroleum, sand and gravel, natural gas, clays.
Menard -----	1,702	1,923	Petroleum, natural gas.
Midland -----	126,102	145,492	Petroleum, natural gas, natural gas liquids, stone.
Milam -----	7,032	9,220	Coal, petroleum, natural gas.
Mills -----	--	166	Stone.
Mitchell -----	36,432	43,633	Petroleum, natural gas, sand and gravel.
Montague -----	22,973	25,348	Do.
Montgomery -----	201,661	238,523	Petroleum, natural gas, natural gas liquids, sand and gravel.
Moore -----	171,732	227,919	Natural gas, natural gas liquids, petroleum, helium.
Morris -----	W	W	Iron ore.
Motley -----	2,965	2,856	Petroleum, sand and gravel, natural gas.
Nacogdoches -----	11,088	20,755	Natural gas, iron ore, petroleum, clays.
Navarro -----	18,980	17,762	Petroleum, natural gas, clays, stone.
Newton -----	6,865	9,014	Petroleum, natural gas, sand and gravel.
Nolan -----	57,833	60,493	Petroleum, cement, natural gas, natural gas liquids, gypsum, stone, sand and gravel.
Nueces -----	174,977	199,240	Natural gas, petroleum, natural gas liquids, cement, lime, sand and gravel.
Ochiltree -----	62,968	69,683	Petroleum, natural gas, natural gas liquids.
Oldham -----	4,389	4,496	Petroleum, sand and gravel, natural gas.
Orange -----	17,255	20,892	Cement, petroleum, natural gas, sand and gravel, clays, natural gas liquids.
Palo Pinto -----	22,232	33,089	Natural gas liquids, natural gas, petroleum, clays, sand and gravel.
Panola -----	66,501	79,239	Natural gas, natural gas liquids, petroleum.
Parker -----	15,724	23,061	Natural gas liquids, natural gas, stone, petroleum, clays.
Parmer -----	W	--	

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Pecos -----	\$583,435	\$801,784	Natural gas, petroleum, natural gas liquids, sulfur, stone, sand and gravel.
Polk -----	21,031	25,945	Petroleum, natural gas, natural gas liquids, sand and gravel.
Potter -----	61,800	83,641	Natural gas, natural gas liquids, cement, petroleum, stone, sand and gravel.
Presidio -----	--	W	Sand and gravel.
Rains -----	2,671	3,224	Natural gas, petroleum.
Randall -----	525	W	Stone.
Reagan -----	98,604	113,977	Petroleum, natural gas liquids, natural gas.
Red River -----	115	174	Petroleum, natural gas.
Reeves -----	103,025	110,358	Natural gas, petroleum, natural gas liquids, sand and gravel.
Refugio -----	326,795	391,949	Petroleum, natural gas, natural gas liquids.
Roberts -----	32,932	49,821	Natural gas, petroleum.
Robertson -----	38	78	Petroleum, natural gas.
Runnels -----	12,201	16,071	Petroleum, natural gas, sand and gravel.
Rusk -----	164,030	182,594	Petroleum, natural gas liquids, natural gas, clays.
San Jacinto -----	2,273	3,001	Natural gas, petroleum.
San Patricio -----	74,363	83,750	Petroleum, natural gas, natural gas liquids, stone, clays.
San Saba -----	--	W	Stone.
Schleicher -----	20,396	25,466	Petroleum, natural gas, stone, sand and gravel.
Scurry -----	905,308	976,187	Petroleum, natural gas liquids, natural gas, magnesium chloride, stone.
Shackelford -----	25,435	30,874	Petroleum, natural gas, natural gas liquids.
Shelby -----	2,010	2,985	Natural gas, petroleum.
Sherman -----	31,190	42,439	Do.
Smith -----	32,131	39,504	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
Somervell -----	1,620	1,377	Sand and gravel.
Starr -----	83,297	89,653	Natural gas, petroleum, natural gas liquids, sand and gravel.
Stephens -----	31,063	43,016	Petroleum, natural gas, natural gas liquids.
Sterling -----	12,963	20,698	Petroleum, natural gas.
Stonewall -----	42,038	46,941	Petroleum, natural gas liquids, natural gas, gypsum.
Sutton -----	40,835	54,302	Natural gas, natural gas liquids, petroleum, stone.
Swisher -----	--	48	Stone.
Tarrant -----	W	W	Cement, sand and gravel, stone, natural gas.
Taylor -----	22,345	25,651	Petroleum, natural gas, stone, sand and gravel, clays.
Terrell -----	18,623	26,084	Natural gas, petroleum.
Terry -----	86,448	104,804	Petroleum, natural gas, sodium sulfate, natural gas liquids.
Throckmorton -----	11,821	13,987	Petroleum, natural gas.
Titus -----	24,654	39,643	Petroleum, coal, natural gas.
Tom Green -----	18,139	21,187	Petroleum, natural gas, natural gas liquids, stone.
Travis -----	W	12,221	Lime, sand and gravel, stone, petroleum, natural gas.
Trinity -----	91	46	Petroleum, natural gas.
Tyler -----	6,709	10,449	Do.
Upshur -----	26,102	29,253	Petroleum, natural gas, sand and gravel.
Upton -----	151,471	179,208	Petroleum, natural gas, natural gas liquids.
Uvalde -----	17,687	16,456	Asphalt, stone, sand and gravel, natural gas.
Val Verde -----	2,296	3,652	Natural gas, sand and gravel, petroleum.
Van Zandt -----	154,394	168,681	Petroleum, salt, natural gas, natural gas liquids, clays.
Victoria -----	53,606	63,394	Natural gas, petroleum, sand and gravel, natural gas liquids.
Walker -----	600	814	Stone, natural gas, clays, petroleum.
Waller -----	185,655	244,260	Natural gas, natural gas liquids, petroleum, sand and gravel.
Ward -----	262,892	269,223	Natural gas, petroleum, natural gas liquids, sand and gravel, salt.
Washington -----	1,650	1,263	Petroleum, natural gas.
Webb -----	41,831	68,141	Natural gas, petroleum, natural gas liquids, sand and gravel, stone.
Wharton -----	113,839	125,490	Natural gas, sulfur, petroleum, natural gas liquids.
Wheeler -----	36,129	58,823	Natural gas, petroleum, natural gas liquids.
Wichita -----	48,597	54,391	Petroleum, natural gas, sand and gravel, natural gas liquids, stone.
Wilbarger -----	26,851	26,310	Petroleum, natural gas liquids, natural gas.

See footnotes at end of table.

Table 2.—Value of mineral production in Texas, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Willacy -----	\$24,212	\$28,402	Natural gas, petroleum, natural gas liquids.
Williamson -----	9,449	7,864	Stone, sand and gravel, petroleum, natural gas.
Wilson -----	4,166	5,854	Petroleum, natural gas, clays.
Winkler -----	236,175	268,713	Natural gas, petroleum, natural gas liquids.
Wise -----	102,688	125,208	Natural gas, natural gas liquids, petroleum, stone, sand and gravel, clays.
Wood -----	398,638	448,385	Petroleum, natural gas liquids, natural gas, clays, sand and gravel.
Yoakum -----	796,715	884,187	Petroleum, natural gas liquids, natural gas, salt.
Young -----	21,072	28,481	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Zapata -----	14,335	31,569	Natural gas, petroleum.
Zavala -----	5,470	8,124	Petroleum, natural gas.
Undistributed ² -----	247,165	258,059	
Total -----	^r 15,525,372	18,143,204	

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

¹ The following counties are not listed because no production was reported: Bandera, Briscoe, Castro, Delta, Floyd, Kendall, Kinney, Lamar, Real, Rockwall, Sabine, and San Augustine. Values of petroleum and natural gas are based on an average price per barrel and cubic foot, respectively, for the State.

² Includes some petroleum (1975), natural gas (1975), and natural gas liquids that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

Table 3.—Indicators of Texas business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	5,292.0	5,535.0	+4.6
Unemployment ----- do-----	295.0	318.0	+7.8
Employment (nonagricultural):			
Mining ----- do-----	133.2	138.6	+4.1
Manufacturing ----- do-----	815.9	858.5	+5.2
Contract construction ----- do-----	290.0	319.4	+10.1
Transportation and public utilities ----- do-----	293.1	291.9	-.4
Wholesale and retail trade ----- do-----	1,100.4	1,165.5	+5.9
Finance, insurance, real estate ----- do-----	247.1	256.1	+3.6
Services ----- do-----	767.4	810.3	+5.6
Government ----- do-----	815.8	846.6	+3.8
Total nonagricultural employment ----- do-----	4,462.9	4,686.9	+5.0
Personal income:			
Total ----- millions--	\$68,327	\$77,436	+13.3
Per capita ----- do-----	\$5,584	\$6,201	+11.0
Construction activity:			
Number of private and public residential units authorized -----	62,749	97,270	+55.0
Value of nonresidential construction ----- millions--	\$1,247.2	\$1,482.1	+18.8
Value of State road contract awards ----- do-----	\$440.0	\$440.0	--
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	6,288	6,663	+6.0
Mineral production value:			
Total crude mineral value ----- millions--	^r \$15,525.4	\$18,143.2	+16.9
Value per capita, resident population ----- do-----	\$1,269	\$1,453	+14.5
Value per square mile ----- do-----	\$58,074	\$67,866	+16.9

^p Preliminary. ^r Revised.

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

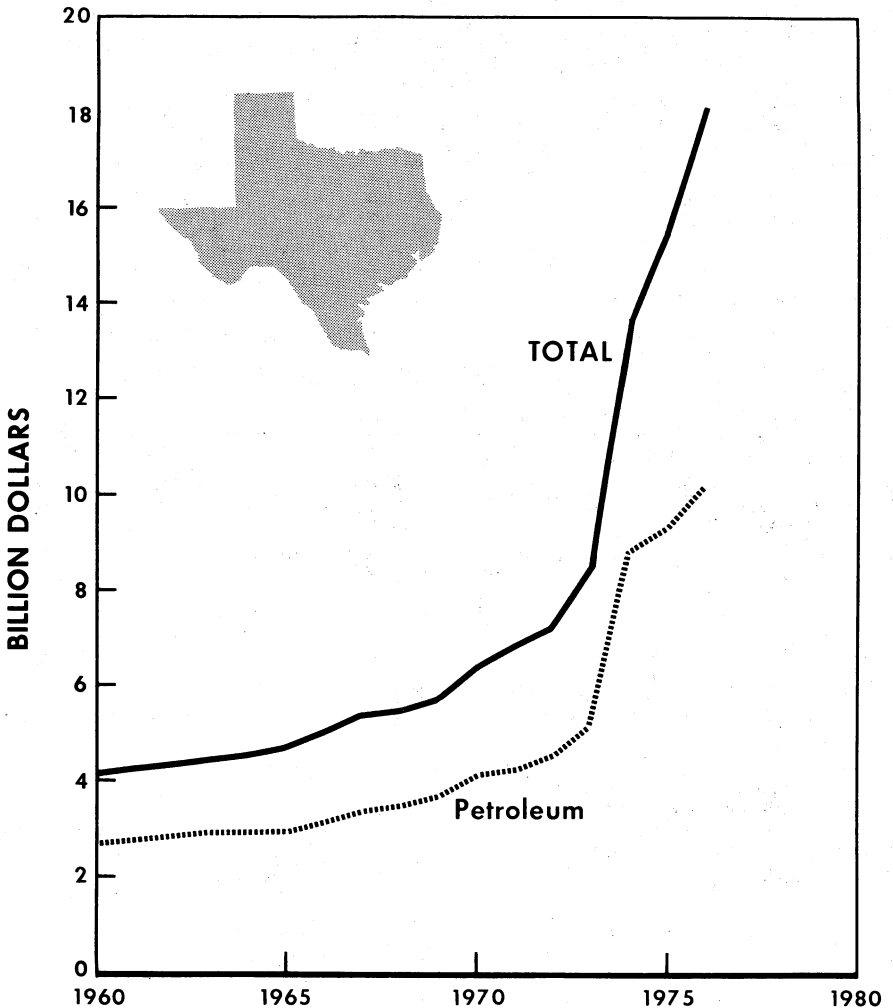


Figure 1.—Value of petroleum and total value of mineral production in Texas.

The TRRC ordered 13 gasfields in Webb County to be consolidated into 1 field designated as the Laredo (Lobo) field, effective February 1, 1976. The area, which includes over 100,000 acres, is one of the largest gas discoveries in the lower 48 States in recent years. The TRRC also adopted temporary field rules for 18 months, to be revised during July 1977. Testimony during the hearing indicated that 71 of 93 wells drilled up to December 1975 resulted in producing gas wells.

The TRRC relaxed somewhat its 1975 order that restricted future use of natural gas for boiler fuel. The principal changes from the earlier phaseout order raised the ceiling on natural gas use as boiler fuel from 100,000 to 3 million cubic feet per day, allowed existing contracts to be renewed provided the contract term is not extended or the quantity of gas increased, redefined the term "boiler fuel" to mean gas used directly for generation of electricity, and required gas utilities to report

deliveries averaging 500,000 cubic feet of gas per day. The main objective of the modified order is to preclude the use of more than 3 million cubic feet of gas per day in new boilers. Users of 3 million cubic feet or more per day still faced a 10% reduction in gas deliveries in January 1981 and a 25% reduction 4 years later.

The Texas Attorney General ruled that the TRRC can order a natural gas pipeline company to transport gas bought by a gas utility. The opinion issued states that the TRRC may require a natural gas pipeline company to transport natural gas for others provided the owner of the gas is a gas utility. The TRRC feels that the ruling could result in increased competition for gas in the field and increased prices, which in turn could lead to greater availability of gas to consumers but at higher prices.

The Texas General Land Office held two oil and gas lease sales in 1976. A total of 406,587 acres was leased for a bonus of \$44,683,067, or an average of \$109.90 per acre. In June, the University of Texas Lands leased slightly over 88,000 acres for oil and gas for a bonus of \$5,640,500, or an average of about \$64.10 per acre. The University Lands also offered for lease five tracts with potash potential in west Texas. The five tracts ranged in size from 2,612

to 2,742 acres. Lease conditions required a minimum bonus of about \$250 an acre, a one-eighth royalty on all potash and allied mineral rights involved, the posting of a \$50,000 bond, and a promise that the successful bidder on each tract would spend at least \$30,000 in 3 years on exploration, starting with the first year of the lease. The University Lands received no bids on the five tracts.

In 1976, the U.S. Department of the Interior conducted two offshore lease sales that included leases in the Western Gulf area (offshore Texas). The first sale was held in February, and 12 tracts were leased containing 63,426 acres for a bonus of \$37,382,176. Average bonus per acre was \$589. The second sale was held in November; four tracts containing 17,308 acres were leased for a bonus of \$31,111,201. Average bonus per acre for this sale was \$1,797.

Amendments to the Federal Coal Leasing Act opened the way for electricity-producing public entities to lease lignite deposits on federally owned land. These amendments will allow the City of Austin, the Lower Colorado River Authority, and other interested and qualified parties to bid on lignite under Camp Swift in Bastrop County.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt (Native).—Two companies each operated a large quarry for the production of asphaltic limestone. Uvalde Rock Asphalt Co. and White's Uvalde Mines, Inc., produced this natural paving material for bituminous aggregate, road-surface treatment, railroad ballast, and unspecified aggregate. The quarries are located in southwestern Uvalde County. Production and value increased almost 5% compared with that of 1975.

Carbon Black.—Production of carbon black was 1,330 million pounds in 1976, up 8.3% from 1,228 million pounds in 1975 but still below the 1,435 million pounds produced in 1974. Texas produced about 44% of the total U.S. output of carbon black in 1976. Total value was \$164 million. Average price per pound was 12.31 cents,

up 1.23 cents per pound over the 1975 value.

A total of 254 million gallons of liquid hydrocarbons was consumed in the production of 1,293 million pounds of carbon black. A total of 8,866 million cubic feet of natural gas was used to produce 37 million pounds of carbon black and for other purposes such as processing energy.

The Cities Service Co. carbon plant in Gaines County, the last channel-type plant in the State, was closed in September. Annual capacity of the remaining 12 furnace-type plants was 1,695 million pounds, or 46% of the U.S. capacity of 3,666 million pounds.

Coal (Lignite).—Lignite was mined in Freestone, Harrison, Hopkins, Milam, and Titus Counties. Production in 1976 was 14,063,000 short tons, up 28% over last year's output of 11,002,000 short tons. Over

95% of the lignite was consumed as fuel for electric power generation, and the remainder was processed into activated carbon. Texas Utilities Generating Co., the State's largest producer, opened the Martin Lake strip mine in Panola County and continued to expand the productive capacity of its Monticello strip mine in Titus County.

Alcoa announced plans to increase production at the Sandow strip mine (Milam County) by almost twofold to fuel a new 545-megawatt electricity generating unit at the company's Rockdale aluminum smelter.

Helium.—The production of helium was 12 million cubic feet (MMcf), a decrease of 24 MMcf from the 1975 output.

Natural Gas.—Average wellhead price for marketed natural gas was 71.8 cents per thousand cubic feet (Mcf), an increase of 38.3% above the average of 51.9 cents per Mcf in 1975. Texas remained the top natural gas producer with an output of 7,192 billion cubic feet, or 36% of the Nation's total. Although output decreased 4%, the unit price increase lifted the value of the marketed gas to an alltime high of \$5,164 million.

Natural gas production was reported from 210 of the State's 254 counties, the same as in 1975. Fifteen of the 210 counties, however, produced over 50% of the total production.

According to the TRRC, the State had a total of 41,657 productive gas wells, an increase of 2,376 wells over yearend 1975.

For the ninth consecutive year the State's natural gas reserves declined. According to the American Gas Association (AGA), the proved gas reserves were 64,651 billion cubic feet as of December 31, 1976, compared with 71,037 billion cubic feet at yearend 1975. Significant decreases in natural gas reserves occurred in district 3 (southeast Texas), district 4 (south Texas), and district 8 (west Texas). The most notable reserve additions were made

in district 10 (Panhandle). However, this district ended the year with a net loss in reserves because production exceeded the additions for the year. Of the State's 12 railroad districts, only 3 ended the year with a net gain in proved natural gas reserves.

Natural Gas Liquids.—Texas remained the Nation's principal producer of natural gas liquids in 1976, supplying 48.9% of the total output. Recovery of natural gasoline and cycle products amounted to 77.6 million barrels valued at \$561 million. Liquefied petroleum gas production was 209.5 million barrels valued at \$1,224 million. Average value of natural gasoline and cycle products was \$7.23 per barrel, up from \$6.08 per barrel in 1975. Average value of liquefied petroleum gases rose from \$4.54 in 1975 to \$5.84 in 1976.

Texas had 352 gas-processing plants, 5 fewer than in 1975, according to the Oil & Gas Journal's annual survey. The daily throughput capacity of the 352 plants at yearend was 27.47 billion cubic feet, down from 29.02 billion cubic feet in 1975 and 29.45 billion cubic feet in 1974.

According to the AGA, proved reserves of natural gas liquids were 2,528 million barrels as of December 31, 1976, down from 2,661 million barrels at yearend 1975.

Eight out of the 12 railroad districts registered declines in natural gas liquids reserves in 1976. The most notable losses were in district 8 (west Texas) and district 3 (southeast Texas). The State's natural gas liquids reserves decreased for the ninth consecutive year, and production declined for the fourth consecutive year.

Petroleum.—Average value of a barrel of crude oil rose sharply from \$7.64 in 1975 to \$8.59 in 1976. The total value of petroleum rose to an alltime high of \$10,218 million, although the 1976 output of 1,190 million barrels was 32 million barrels below 1975 production. Crude oil production declined for the fifth consecutive year.

Table 4.—Texas: Production and value of petroleum, natural gas, and natural gas liquids

Year	Crude petroleum		Natural gas ¹	
	Thousand 42-gallon barrels	Value (thousands)	Million cubic feet	Value (thousands)
1972 -----	1,301,685	\$4,536,077	8,657,840	\$1,419,886
1973 -----	1,294,671	5,157,623	8,513,850	1,735,221
1974 -----	1,262,126	8,773,003	8,170,798	2,541,118
1975 -----	1,221,929	9,336,570	7,485,764	3,885,112
1976 -----	1,189,523	10,217,702	7,191,859	5,163,755

	Natural gas liquids					
	Natural gasoline and cycle products		LPG and ethane		Total	
	Thousand 42-gallon barrels	Value (thousands)	Thousand 42-gallon barrels	Value (thousands)	Thousand 42-gallon barrels	Value (thousands)
1972 -----	92,437	\$294,163	226,624	\$428,319	319,061	\$722,482
1973 -----	92,743	347,393	221,686	539,685	314,429	937,078
1974 -----	88,316	629,529	213,756	1,004,653	302,072	1,634,182
1975 -----	78,835	479,700	212,635	965,363	291,470	1,445,063
1976 -----	77,578	560,831	209,514	1,223,562	287,092	1,784,393

¹ Marketed production, gas either sold or consumed by producers including losses in transmission, amounts added to storage, and increases in gas pipelines.

Table 5.—Texas: Comparison of crude oil, natural gas, and natural gas liquids production in Texas and the United States (Million barrels of crude oil equivalent)

Commodity	Production as oil equivalent ¹				Change from 1975 (percent)		Distribution percentage ²				Texas as percent of United States output	
	Texas		United States		Texas	United States	Texas		United States		1975	1976
	1975	1976	1975	1976			1975	1976	1975	1976		
Crude oil ----	1,222	1,190	3,057	2,976	-2.6	-2.6	44.1	44.4	43.2	42.7	40.0	40.0
Natural gas -	1,337	1,284	3,591	3,563	-4.0	-.8	48.2	47.9	50.7	51.2	37.2	36.0
Natural gas liquids ----	213	209	435	428	-1.9	-1.6	7.7	7.8	6.1	6.1	49.0	48.8
Total oil equivalent..	2,772	2,683	7,083	6,967	-3.2	-1.7	100.0	100.0	100.0	100.0	39.1	38.5

¹ One barrel of crude oil is equivalent to 5,600 cubic feet of natural gas or 57.6 gallons of natural gas liquids.

² Totals may not add to 100 due to rounding.

Table 6.—Texas: Crude oil, natural gas, and natural gas liquids reserves-to-production ratio in Texas and the United States¹
(Million barrels of crude oil equivalent)

Commodity	Reserves								Reserves percentage			
	Reserves				Texas as percent of United States output		Change from 1975 (percent)		Reserves-to-production ratio			
	Texas		United States		1975	1976	Texas	United States	Texas		United States	
	1975	1976	1975	1976					1975	1976	1975	1976
Crude oil -----	10,080	9,226	32,682	30,942	30.8	29.8	-8.5	-5.3	8.2	7.8	10.7	10.4
Natural gas -----	12,685	11,544	40,750	38,576	31.1	29.9	-9.0	-5.3	9.5	9.0	11.3	10.8
Natural gas liquids -----	1,940	1,843	4,570	4,668	42.4	39.5	-5.0	2.1	9.1	8.8	10.5	10.9
Total oil equivalent ----	24,705	22,613	78,002	74,186	31.7	30.5	-8.5	-4.9	8.9	8.4	11.0	10.6

¹ Estimated proved reserves and production from American Gas Association and American Petroleum Institute. One barrel of crude oil is equivalent to 5,600 cubic feet of natural gas or 57.6 gallons of natural gas liquids.

Table 7.—Texas: Production trends of crude oil, natural gas, and natural gas liquids
(Million barrels of crude oil equivalent)

Year	Production ¹				Percentage of—							
	Production ¹				Annual total			Change from previous year				
	Oil	Gas ²	Liquids	Total	Oil	Gas	Liquids	Oil	Gas	Liquids	Total	
1972 -----	1,302	1,546	233	3,081	42.2	50.2	7.6	+6.5	+1.2	+4.0	+3.6	
1973 -----	1,295	1,520	229	3,044	42.5	50.0	7.5	-5	-1.7	-1.7	-1.2	
1974 -----	1,262	1,459	220	2,941	42.9	49.6	7.5	-2.5	-4.0	-3.9	-3.4	
1975 -----	1,222	1,337	213	2,772	44.1	48.2	7.7	-3.2	-8.4	-3.2	-5.8	
1976 -----	1,190	1,284	209	2,683	44.4	47.9	7.8	-2.6	-4.0	-1.9	-3.2	

¹ One barrel of crude oil is equivalent to 5,600 cubic feet of natural gas or 57.6 gallons of natural gas liquids.

² Marketed gas.

Production was reported from 205 of the State's 254 counties; 12 counties, however, produced over 50% of the State's total. According to the TRRC, the average output from the State's 160,546 productive oil wells was 20.2 barrels per day, down from 20.9 barrels in 1975.

The State's oil industry ended 1976 with 91.0 million barrels of crude oil above ground, a 14% gain from the start of the year. At yearend, refinery stocks of crude oil were 21.8 million barrels, or about 24% of the total. Stocks at tank farms and in

pipelines were 58.7 million barrels and on leases, 10.5 million barrels. Stocks of refined products were 118.9 million barrels, or 2.5%, higher than at the beginning of the year.

Refinery capacity in the State at yearend was 4,226,387 barrels of crude oil per calendar day, or 25.6% of the U.S. refining capacity. The State's 50 refineries processed 1,304 million barrels of crude oil in 1976, or 26.6% of the crude oil refined in the United States.

Table 8.—Texas: Stocks of crude petroleum at refineries, tank farms, and gathering systems in Texas as of the last day of each month, in 1976
(Thousand 42-gallon barrels)

Month	Refineries	Tank farms and pipelines	Lease tanks	Total
January	20,863	61,932	9,635	92,430
February	18,373	59,512	10,500	88,385
March	19,456	59,050	10,233	88,739
April	23,450	58,628	10,319	92,397
May	20,162	58,210	10,564	88,936
June	21,178	58,857	10,337	90,372
July	23,970	60,175	10,450	94,595
August	23,261	59,772	10,575	93,608
September	26,028	60,461	10,262	96,751
October	26,152	63,170	11,123	100,445
November	25,689	61,078	10,975	97,742
December	21,796	58,684	10,581	91,011

Table 9.—Texas: Stocks of refined products held by refining and pipeline companies in 1976, by month
(Thousand 42-gallon barrels)

Month	Naphthas	Gasoline	Kerosine	Fuel oil		Jet fuel	Miscellaneous products	Total refined products
				Distillate	Residual			
January	1,782	37,611	1,764	19,690	5,308	4,498	39,318	109,971
February	1,638	37,271	1,564	15,970	5,600	4,369	40,171	106,583
March	1,539	36,290	1,404	14,256	5,546	4,720	36,530	100,285
April	1,354	34,397	1,451	13,990	5,795	4,959	36,751	98,697
May	1,337	33,964	1,803	17,729	5,560	5,587	39,004	104,984
June	1,363	33,536	1,944	19,379	5,259	5,739	39,628	106,848
July	1,417	33,126	1,710	19,404	4,955	5,242	40,206	106,060
August	1,592	33,433	1,739	22,216	4,935	5,186	39,906	109,007
September	1,530	36,006	1,642	25,298	5,501	5,280	38,465	113,722
October	1,816	38,225	2,023	26,382	6,036	5,930	37,747	118,159
November	1,833	39,763	2,117	26,104	6,675	5,330	39,020	120,842
December	1,840	42,231	1,859	21,855	6,198	5,677	39,236	118,896

Table 10.—Texas: Crude petroleum production, indicated demand, and stocks in 1976, by month
(Thousand 42-gallon barrels)

Month	Production	Indicated demand	End-of-month stocks originating within Texas
January	102,633	91,823	102,685
February	95,826	99,734	98,772
March	102,159	100,472	100,438
April	98,003	99,044	99,378
May	101,027	101,927	98,456
June	96,730	95,249	100,150
July	100,804	101,450	99,329
August	100,434	100,338	99,476
September	96,801	96,284	100,073
October	100,395	94,768	105,740
November	96,000	98,094	103,679
December	98,711	103,016	99,398
Total:			
1976	1,189,523	1,182,204	XX
1975	1,221,929	1,224,611	XX

XX Not applicable.

Table 11.—Texas: Runs to stills and output of refineries in 1976, by month
(Thousand 42-gallon barrels)

Month	Input				Output					
	Crude	Products	Lubri- cating oil	Gasoline	Kerosine	Fuel oil		Jet fuel	Petro- chemical feed- stocks	Miscel- laneous
						Distillate	Residual			
January	104,508	7,211	1,618	51,577	2,057	23,771	8,857	6,419	8,330	11,743
February	100,514	8,895	1,757	48,576	2,392	24,759	8,646	6,163	7,660	12,127
March	107,161	9,865	1,759	54,751	1,775	25,317	9,670	6,625	8,489	12,727
April	104,696	8,990	2,329	53,382	1,889	21,646	9,409	6,799	8,151	12,539
May	110,578	7,384	2,373	56,056	1,289	23,945	9,407	7,212	7,680	13,303
June	107,704	6,695	2,378	54,567	1,175	23,860	7,896	6,507	7,469	13,563
July	110,905	8,633	2,305	56,671	1,312	24,750	9,180	6,805	8,323	12,788
August	111,491	8,823	2,267	54,811	1,836	25,291	9,431	7,211	8,135	13,483
September	109,295	10,657	2,284	54,871	1,959	25,289	9,429	7,266	8,976	12,812
October	108,686	9,389	2,414	54,092	2,269	24,249	9,522	7,429	8,826	11,236
November	112,165	6,575	2,227	52,236	2,011	25,919	10,792	6,820	8,796	12,827
December	116,799	12,083	2,408	57,183	2,533	28,693	11,771	6,147	9,587	13,106
Total	1,304,462	105,210	26,119	648,273	22,462	297,489	114,010	81,433	100,872	162,224

Texas' proved crude oil reserves diminished by 854 million barrels in 1976, marking the fourth straight year that reserves have declined according to estimates of the American Petroleum Institute (API). At yearend, reserves of crude oil were 9,226 million barrels. It is noted that 11 of the 12 railroad districts registered net losses in reserves in 1976. Only district 1 (south-central Texas), which has the smallest reserve base of the 12 districts, ended the year with a small gain in proved reserves. Texas had 29.8% of the Nation's crude oil

reserves, down about 1.0% from the 1975 figure.

According to the API and AGA, the petroleum industry drilled a total of 12,410 wells in Texas in search of oil and gas, up 324 wells over 1975. Of this total, 3,269 were wildcat wells that resulted in the discovery of 386 oil and 692 gas pools for an overall success ratio of 33%.

Development drilling totaled 9,141 wells. Of this total, 5,393 were oil productive and 1,751 were gas productive for an overall success ratio of 78.2%.

Table 12.—Texas: Estimated proved reserves of natural gas, natural gas liquids, and crude oil, by railroad district

Railroad district	Proved reserves Dec. 31, 1975	Extensions and revisions	New fields and new pools	Proved reserves Dec. 31, 1976	Change from Dec. 31, 1975
NATURAL GAS (MILLION CUBIC FEET)					
1	1,363,529	-117,799	22,776	1,164,851	-198,678
2	6,186,901	383,526	183,091	6,295,697	108,796
3	16,426,950	-1,493,905	433,442	14,191,629	-2,235,321
4	15,461,167	-1,042,760	394,578	13,315,253	-2,145,914
5	950,557	-69,446	13,519	819,266	-131,291
6	4,203,032	279,071	107,785	4,334,567	131,535
7B	620,212	202,110	12,773	748,947	128,735
7C	2,086,401	223,030	12,928	2,053,997	-32,404
8	12,541,137	-199,513	50,683	10,879,589	-1,661,548
8A	1,389,787	96,462	8,659	1,324,061	-65,726
9	1,316,277	21,942	11,320	1,216,469	-99,808
10	8,490,904	930,218	27,321	8,307,084	-183,820
Total	71,036,854	-787,064	1,285,275	64,651,410	-6,385,444
NATURAL GAS LIQUIDS (THOUSAND BARRELS)					
1	25,494	2,178	497	25,074	-420
2	118,273	10,568	3,281	121,475	3,202
3	350,274	1,665	2,733	311,978	-38,296
4	420,310	32,858	15,182	408,968	-11,342
5	69,049	-529	117	64,851	-4,198
6	342,086	17,204	2,117	334,665	-7,421
7B	58,397	18,004	1,235	66,932	8,535
7C	123,683	8,081	213	114,049	-9,634
8	545,384	-17,909	120	468,205	-77,179
8A	263,338	34,364	245	252,435	-10,903
9	73,313	12,818	1,999	78,441	5,128
10	271,067	49,228	969	280,764	9,697
Total	2,660,668	168,530	23,708	2,527,837	-132,831
CRUDE OIL (THOUSAND BARRELS)					
1	126,457	30,394	1,812	138,510	12,053
2	563,204	512	1,376	502,109	-61,095
3	1,244,579	-68,500	5,047	1,025,889	-218,690
4	193,370	-6,937	1,982	158,803	-34,567
5	91,267	4,377	240	77,310	-13,957
6	1,773,893	110,148	1,056	1,743,103	-30,790
7B	227,772	5,101	5,171	204,514	-23,258
7C	185,234	22,795	1,716	183,120	-2,114
8	2,922,387	39,581	2,072	2,710,058	-212,329
8A	2,292,651	131,083	4,756	2,067,714	-224,937
9	304,510	-4,233	5,103	268,445	-36,065
10	154,711	8,633	1,569	146,675	-8,036
Total	10,080,085	273,054	31,900	9,226,250	-853,785

Sources: American Gas Association and American Petroleum Institute.

Table 13.—Texas: Oil and gas well drilling completions, by county, in 1976

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Anderson	5	--	4	1	--	7	17	108,835
Andrews	232	6	18	8	2	4	270	1,432,168
Angelina	1	--	4	--	--	2	2	12,945
Aransas	--	3	--	1	2	4	15	143,999
Archer	212	--	116	4	--	10	342	658,968
Atascosa	24	3	5	5	1	5	43	167,690
Austin	2	9	1	--	2	11	25	200,949
Bastrop	--	--	1	--	--	7	8	17,140
Baylor	4	--	5	2	--	10	21	81,535
Bee	12	21	22	1	8	16	80	403,906
Bexar	17	--	1	--	--	--	18	13,664
Borden	19	--	5	--	--	10	34	270,415
Bowie	--	--	1	--	--	4	5	34,880
Brazoria	15	14	9	2	13	18	71	598,500
Brazos	--	--	--	2	--	--	2	18,060
Brooks	3	20	13	--	5	7	48	403,361
Brown	39	20	31	6	4	11	111	254,488
Burleson	4	1	1	1	5	2	14	60,994
Caldwell	43	--	5	--	--	1	49	119,735
Calhoun	--	4	3	2	6	19	35	259,926
Callahan	41	13	32	3	1	18	108	272,752
Cameron	--	2	2	--	--	12	16	122,216
Camp	--	2	1	--	--	1	4	38,915
Carson	39	2	11	--	--	1	53	170,146
Cass	2	--	--	--	--	5	7	67,867
Chambers	6	10	15	3	3	24	61	544,620
Cherokee	--	1	--	--	--	7	8	71,481
Childress	--	--	--	--	--	1	1	4,915
Clay	36	--	10	3	--	19	68	330,683
Cochran	47	22	1	--	--	4	74	366,425
Coke	23	1	7	5	--	20	56	287,538
Coleman	19	7	17	3	8	23	82	233,540
Collingsworth	--	7	--	--	--	--	7	13,410
Colorado	--	18	17	3	37	31	106	633,684
Comanche	4	11	3	--	2	12	32	88,919
Concho	5	2	5	1	3	11	27	84,507
Cooke	54	--	24	2	--	11	91	200,232
Coryell	--	--	--	--	--	1	1	5,151
Cottle	4	2	5	2	1	16	30	163,495
Crane	194	6	8	3	1	7	219	890,190
Crockett	50	73	27	6	17	25	198	1,099,008
Crosby	9	--	--	1	--	1	11	52,049
Culberson	6	--	--	--	--	6	12	46,106
Dallam	--	--	--	--	--	1	1	6,604
Dawson	53	--	6	4	--	16	79	652,011
Delta	--	--	--	--	--	2	2	12,278
Denton	--	9	2	--	--	4	15	55,413
De Witt	3	11	6	--	8	17	45	380,851
Dickens	--	--	1	--	--	7	8	45,836
Dimmit	17	34	7	6	7	20	91	437,356
Duval	35	28	33	2	17	23	143	529,133
Eastland	26	9	32	3	2	18	90	290,178
Ector	157	--	9	--	--	3	169	889,273
Edwards	--	32	12	1	2	3	50	265,479
Erath	--	1	--	--	2	12	15	53,325
Falls	--	--	1	--	--	2	3	11,348
Fayette	3	--	--	1	--	2	6	15,174
Fisher	25	--	5	5	1	20	56	293,432
Floyd	--	--	--	--	--	1	1	8,050
Foard	--	4	--	1	--	5	10	35,941
Fort Bend	21	7	10	--	8	7	53	277,532
Franklin	3	--	1	--	--	1	5	37,535
Freestone	--	19	4	--	3	5	31	300,958
Frio	311	4	2	29	1	6	353	2,232,177
Gaines	19	3	10	1	--	16	49	389,422
Galveston	8	3	8	7	12	14	52	517,436
Garza	66	--	1	5	--	23	95	461,541
Glasscock	111	--	10	5	3	5	134	836,987
Goliad	17	29	15	--	21	25	107	530,858
Gonzales	3	--	--	8	--	4	15	94,407
Gray	22	4	5	--	--	2	33	120,813
Grayson	4	1	2	5	1	15	28	181,344
Gregg	5	2	--	--	1	1	7	38,811
Grimes	--	1	2	1	1	1	5	41,330
Guadalupe	47	1	--	--	--	2	52	114,723
Hale	11	--	1	--	--	1	13	80,073
Hall	--	--	--	--	--	2	2	12,940

See footnote at end of table.

Table 13.—Texas: Oil and gas well drilling completions, by county, in 1976
—Continued

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Hamilton	--	--	--	--	--	7	7	28,052
Hansford	6	23	12	--	2	4	47	290,219
Hardeman	1	--	2	2	--	6	11	91,593
Hardin	34	3	11	1	3	2	54	238,933
Harris	22	9	8	2	5	8	54	344,960
Harrison	14	12	8	1	1	11	47	321,979
Hartley	--	--	--	--	--	2	2	9,340
Haskell	13	1	20	1	--	12	47	214,663
Hays	--	--	--	--	--	1	1	1,052
Hemphill	25	48	9	4	2	7	95	1,013,050
Henderson	--	5	--	--	--	2	7	75,844
Hidalgo	--	23	8	--	3	9	43	443,882
Hill	--	--	--	--	--	1	1	1,275
Hockley	80	1	11	2	1	6	101	581,984
Hood	--	1	1	--	1	1	4	18,837
Hopkins	--	--	--	--	--	5	5	88,722
Houston	7	5	2	--	--	2	16	154,263
Howard	159	10	10	2	--	7	178	645,997
Hudspeth	--	--	--	--	--	2	2	10,738
Hunt	--	--	--	--	--	4	4	28,461
Hutchinson	11	--	2	--	--	3	16	65,189
Irion	63	2	5	8	8	3	94	635,560
Jack	62	59	48	2	10	53	234	1,053,945
Jackson	5	33	16	1	18	20	93	496,263
Jasper	6	--	2	--	1	8	17	149,292
Jefferson	12	3	6	2	3	12	38	306,648
Jim Hogg	5	1	8	1	3	10	28	102,564
Jim Wells	16	33	20	--	2	13	84	451,011
Jones	31	--	22	4	--	33	90	262,995
Karnes	1	1	5	--	5	8	20	173,343
Kaufman	--	--	--	--	--	3	3	30,801
Kenedy	2	12	4	--	3	8	29	259,275
Kent	36	--	4	1	--	9	50	329,220
Kerr	--	--	--	--	--	1	1	3,336
Kimble	--	--	1	--	1	10	12	20,122
King	30	3	14	2	2	19	70	357,751
Kinney	--	--	--	--	--	2	2	9,358
Kleberg	15	12	13	3	3	7	53	420,527
Knox	29	--	32	2	--	16	79	218,896
Lamb	20	--	--	1	--	1	22	124,553
Lampasas	--	--	--	--	--	1	1	2,570
La Salle	6	2	2	8	8	10	36	235,969
Lavaca	8	39	24	3	24	24	122	752,721
Lee	--	--	1	1	4	3	9	37,373
Leon	--	6	--	1	1	3	11	93,187
Liberty	19	2	10	1	9	13	54	358,498
Limestone	--	3	3	--	1	7	14	67,923
Lipscomb	9	19	8	--	2	1	39	344,990
Live Oak	4	15	9	3	6	36	73	504,832
Loving	2	10	4	--	4	4	24	408,052
Lubbock	--	--	1	1	--	5	7	53,090
Lynn	4	--	--	--	--	1	5	30,000
McCulloch	4	--	4	3	6	26	43	56,067
McLennan	1	--	--	--	--	1	2	4,526
McMullen	3	4	11	3	1	10	32	178,410
Madison	4	2	2	--	--	1	9	73,110
Marion	13	1	1	--	--	2	17	54,333
Martin	121	--	15	2	--	4	142	1,266,189
Matagorda	4	--	11	3	6	26	54	473,377
Maverick	12	20	29	5	7	26	99	257,163
Medina	62	7	4	1	--	1	75	79,356
Menard	--	--	--	3	--	8	11	31,807
Midland	36	--	3	1	--	3	43	384,793
Milam	16	2	4	5	1	2	30	74,265
Mills	--	--	--	--	--	1	1	8,310
Mitchell	113	--	21	2	1	13	150	485,313
Montague	66	--	6	4	--	21	97	332,534
Montgomery	8	--	1	1	--	5	15	102,318
Moore	13	8	1	--	--	--	22	60,271
Motley	--	--	1	--	--	2	3	15,518
Nacogdoches	1	9	--	--	1	2	13	113,677
Navarro	49	1	12	--	--	6	68	126,440
Newton	4	--	1	1	2	5	13	108,924
Nolan	11	2	1	3	--	7	24	137,636
Nueces	24	31	22	--	3	12	92	633,318
Ochiltree	30	16	4	--	2	--	52	402,339

See footnote at end of table.

Table 13.—Texas: Oil and gas well drilling completions, by county, in 1976
—Continued

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Oldham	--	--	--	--	--	1	1	9,550
Orange	10	--	1	1	--	6	18	122,234
Palo Pinto	11	74	56	2	16	59	218	891,510
Panola	6	27	5	--	2	4	44	325,964
Parker	--	23	5	--	17	27	72	368,319
Pecos	72	40	26	3	19	28	188	1,174,502
Polk	4	--	6	1	5	9	25	194,698
Potter	66	2	5	--	--	--	73	163,631
Rains	--	--	--	--	--	1	1	14,676
Reagan	102	--	6	2	--	2	112	686,648
Red River	1	--	1	--	--	5	7	26,890
Reeves	19	10	9	3	5	11	57	377,159
Refugio	26	18	8	1	12	17	82	486,657
Roberts	4	23	10	1	--	5	48	423,191
Robertson	1	1	--	1	--	1	4	35,545
Rockwall	--	--	--	--	--	1	1	6,451
Runnels	20	2	26	23	4	55	130	552,571
Rusk	15	18	1	1	4	8	47	331,014
San Augustine	--	--	--	--	--	1	1	13,492
San Jacinto	--	1	2	1	--	5	9	79,943
San Patricio	7	19	13	2	10	12	63	523,205
Schleicher	1	24	14	3	10	16	68	472,619
Scurry	127	--	18	2	--	12	159	741,593
Shackelford	96	9	49	4	2	21	181	384,108
Shelby	8	4	3	--	2	6	23	100,018
Sherman	3	6	3	--	--	1	13	64,928
Smith	6	6	2	2	--	11	27	237,690
Somervell	--	--	--	--	--	1	1	6,360
Starr	17	9	17	3	18	9	78	309,907
Stephens	84	29	21	3	5	33	175	577,973
Sterling	31	14	6	7	3	6	67	509,368
Stonewall	25	--	12	1	--	23	61	279,811
Sutton	2	121	42	1	18	12	196	1,421,818
Tarrant	--	--	--	--	1	--	1	6,150
Taylor	51	--	30	1	--	18	100	359,893
Terrell	--	--	3	1	3	10	17	194,332
Terry	65	3	6	3	--	8	80	566,317
Throckmorton	24	--	38	2	--	20	84	241,810
Titus	6	--	1	--	--	--	7	29,107
Tom Green	22	--	3	4	1	9	39	166,364
Travis	--	--	--	--	--	3	3	3,711
Trinity	--	--	--	--	1	1	2	14,725
Tyler	--	1	2	1	4	14	22	230,543
Upshur	3	5	1	--	1	3	13	105,616
Upton	66	1	5	4	3	3	82	396,129
Val Verde	--	3	4	--	3	5	15	155,616
Van Zandt	8	2	2	--	2	5	19	143,809
Victoria	11	23	14	2	25	19	94	466,793
Walker	--	--	--	--	--	1	1	17,860
Waller	--	8	2	--	1	2	13	106,050
Ward	80	7	4	5	8	8	112	764,718
Washington	2	--	2	--	--	4	8	32,589
Webb	11	114	39	3	32	30	229	1,427,411
Wharton	19	34	46	3	27	36	165	817,519
Wheeler	--	9	2	--	4	4	19	306,336
Wichita	355	--	67	--	--	4	426	621,722
Wilbarger	33	--	15	1	--	6	55	116,032
Willacy	--	2	--	--	1	4	7	43,059
Williamson	1	--	--	--	--	5	6	5,375
Wilson	16	--	6	6	--	3	31	139,367
Winkler	49	5	8	4	3	5	74	469,615
Wise	30	36	11	--	--	12	89	552,236
Wood	61	1	5	1	--	5	73	427,359
Yoakum	70	--	2	2	--	8	82	474,583
Young	139	4	82	8	--	34	267	707,962
Zapata	3	30	16	--	30	10	89	734,450
Zavala	10	3	7	16	3	18	57	262,760
Offshore 600	--	--	--	--	--	1	1	11,550
Offshore 602	--	--	--	--	1	2	3	21,427
Offshore 603	--	--	--	--	1	6	7	57,513
Offshore 604	--	1	--	--	--	2	3	27,215
Offshore 605	--	--	--	--	--	2	2	20,223
Offshore 700	--	--	--	--	--	1	1	7,054
Offshore 701	--	--	--	--	--	2	2	17,077
Offshore 702	--	--	--	--	1	11	12	130,124

See footnote at end of table.

Table 13.—Texas: Oil and gas well drilling completions, by county, in 1976
—Continued

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Offshore 703 -----	--	2	--	--	3	13	18	147,531
Offshore 704 -----	--	2	--	--	1	5	8	64,102
Offshore 705 -----	--	--	4	--	--	3	7	76,212
Offshore 706 -----	--	--	--	--	1	6	7	76,831
Offshore 707 -----	--	--	--	--	--	3	3	17,760
Offshore 708 -----	3	--	3	--	2	9	17	179,209
Offshore 709 -----	--	--	32	--	--	35	67	536,642
Offshore 710 -----	--	--	--	--	--	1	1	14,605
Offshore 711 -----	--	1	31	--	--	24	56	472,607
Offshore 712 -----	--	--	--	--	1	7	8	62,231
Offshore 713 -----	--	--	--	--	--	2	2	9,751
Offshore 714 -----	--	--	--	--	--	1	1	9,400
Total -----	5,393	1,751	1,997	386	692	2,191	12,410	64,661,898

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

Petrochemicals.—The petrochemical industry remained the major contributor of value-added income in the State's mineral manufacturing economy. The Texas gulf coast continued to be the most desirable area for locating new plants as well as expansions to existing facilities. The following are some of the notable projects that were planned, started, or completed during the year.

Dart Industries and El Paso Products Co. will construct an additional low-density polyethylene unit at the company's Bayport plant. The unit will have a capacity of 150 million pounds per year and was scheduled to be in operation early in 1977.

Lonza, Inc., a U.S. unit of Swiss Aluminum, began construction of a \$30 million plant to produce chemical raw materials for pigment, pharmaceutical, and agrichemical industries. Lonza officials say the plant will be the forerunner of a petrochemical complex at the Bayport site near Galveston Bay.

U.S. Industrial Chemical Co. will construct a 600-million-pound-per-year acetic acid plant at Deer Park, scheduled for startup in 1979.

E. I. du Pont de Nemours & Co., Inc., planned an 80% expansion in production of butanediol and tetrahydrofuran at its La Porte facility. First phase of the planned expansion was scheduled for startup in April 1977 with further expansion planned for completion in 1978.

Champlin and others announced plans to construct a \$600 million ethylene plant

about 10 miles southwest of the company's Corpus Christi refinery. Feedstocks for this facility would be supplied by the Champlin crude oil refinery, which was undergoing a \$210 million expansion scheduled for completion in early 1977. The ethylene plant will have a productive capacity of 1.2 billion pounds annually. The project is a joint venture with ICI America, ICI United States, and Soltex Polymer Corp.

Union Carbide Corp. planned to construct a new plant at Texas City to produce ethylene dioxide. Plant capacity would be 500 million pounds per year. The plant is scheduled for completion in 1979. In August, Union Carbide also announced plans to expand isopropanol production at its Texas City complex from 500 to 600 million pounds annually.

Celanese Plastics Co. has increased the capacity of its Bishop plant to produce Celcon acetal copolymer by 50%, to more than 100 million pounds per year.

Arco Chemical Co. and E. I. du Pont de Nemours & Co., Inc., will construct and operate a petrochemical-manufacturing facility under the name Centennial Hydrocarbons, Inc., in the Texas gulf coast area. The facility will have the capacity to refine 100,000 barrels of crude oil per day and is scheduled to be in operation in 1981. Estimated construction cost is in the billion-dollar range. The plant will have an annual capacity of over 1 billion pounds of ethylene as well as other raw materials for the production of manmade fibers, plastics, and elastomers.

Celanese Chemical Co. announced plans to expand the ethylene oxide/ethylene glycol capacity at its Clear Lake plant, boosting the annual capacity to about 500 million pounds per year. Completion target is in 1977.

Quintana-Howell's petrochemical complex in Corpus Christi will add a multi-million-dollar hydrocracking unit and hydrogen plant by the third quarter of 1977, making the facility one of the 10 largest benzene plants in the Nation. Annual capacity will be 90 million gallons of benzene in addition to other aromatics. The hydrocracking unit will be redesigned to convert semifinished crude into naphtha for use in producing aromatic petrochemicals. The expansion will enable the plant to operate solely from its own crude supply.

E. I. du Pont de Nemours & Co., Inc.'s, new plant, with an annual capacity of 225 million pounds of high-density polyethylene resin, began operation near Victoria. The plant was built to support a continued 9% to 10% annual growth in the molding, film, wire and cable, and polyethylene pipe markets.

Celanese Chemical Co. has announced plans to convert boilers at its plants in Pampa, Bishop, Bay City, and Clear Lake to burn coal as boiler fuel rather than natural gas. The first plant to be converted will be in Pampa. Coal consumption at the Pampa plant is expected to be 850,000 tons per year.

Arco Chemical Co. began operating a new ethylene plant with a rated capacity of 1.3 billion pounds of ethylene per year. The unit is one of four that Arco Chemical will build at its Channelview complex near Houston.

Gulf Oil Chemicals Co. added 30 million pounds per year of low-density-polyethylene capacity at its Cedar Bayou plant. This expansion, the first of three, raised the total low-density-polyethylene capacity of the Cedar Bayou plant to 850 million pounds per year.

NONMETALS

Value of nonmetals produced in Texas in 1976 totaled \$778 million, an increase of 9.7% compared with the 1975 value. Nonmetals accounted for 4.3% of the State's total raw mineral value. The relative por-

portion of the State's mineral value derived from nonmetallic minerals rose slightly in 1976, reversing a 3-year trend toward declining relative contribution as a result of soaring mineral fuel values. The principal nonmetallic minerals produced in 1976 were cement, sulfur, sand and gravel, and stone.

Output increases in 1976 were noted for barite (ground), cement, fire clay, fuller's earth, fluorspar, graphite, gypsum (crude and calcined), salt, sand and gravel, sodium sulfate (natural), recovered sulfur, talc, and vermiculite (exfoliated). Ball clay, bentonite, common clay and shale, kaolin, lime, perlite (expanded), industrial sand, dimension stone, crushed stone, and Frasch sulfur experienced production declines in 1976. Fire clay declined in total value despite an increase in production; common clay and shale, kaolin, and perlite (expanded) all increased in value in spite of production declines. Average unit value for 4 nonmetallic commodities dropped in 1976, whereas the remaining 18 commodities realized gains in average value.

Barite (ground), perlite (expanded), and vermiculite (exfoliated) were not mined in Texas. These products are produced from out-of-State crude ore imports.

Barite.—Although no barite was mined in Texas in 1976, seven companies processing out-of-State ore operated nine grinding and crushing plants. Output of ground barite increased nearly 37% to 584,665 short tons, and value of processed barite increased 51% to over \$26 million.

Almost 99% of the ground barite produced in Texas was used as a weighting agent in well-drilling fluids. Other uses included filler or extender in rubber and other products. Processing plants were operated in Cameron, Galveston, Harris, and Nueces Counties.

Cement.—Reflecting the overall recovery of the economy and general improvement in the construction industry, portland cement production in Texas rose over 5% in 1976. Portland cement shipments increased nearly 3%, and value of shipments rose nearly 21% compared with that of 1975. The average value per ton of portland cement increased from \$31.24 in 1975 to \$36.69 in 1976. Masonry cement production and shipments increased 16% and 18%, respectively. Value of masonry cement shipments climbed nearly 50%

Table 14.—Texas: Portland cement salient statistics
(Short tons)

	1975	1976
Number of active plants	18	18
Production	7,074,017	7,437,891
Shipments from mills:		
Quantity	7,195,380	7,387,715
Value	\$224,803,785	\$271,065,798
Stocks at mills, Dec. 31	470,715	542,782

Table 15.—Texas: Masonry cement salient statistics
(Short tons)

	1975	1976
Number of active plants	12	12
Production	189,495	220,342
Shipments from mills:		
Quantity	180,965	212,922
Value	\$7,089,015	\$10,595,637
Stocks at mills, Dec. 31	21,156	19,154

owing to a 27% increase in average value per ton. Texas ranked second in the Nation in cement output in 1976.

Eighteen plants were operated by 13 companies for the production of cement in 1976. Finished portland cement in Texas was sold to ready-mix companies (62.5%), other contractors (11.3%), concrete products manufacturers (10.0%), building materials dealers (7.3%), highway contractors (4.1%), and miscellaneous customers and government agencies (4.8%). Masonry cement was produced at 12 plants operated by 10 companies. Three plants reported no production of masonry cement but did report masonry cement sales. Masonry cement was used in mortar for masonry construction.

Texas cement plants operated at about 74% of installed capacity in 1976. Installed productive capacity in Texas was 9.3% of the total U.S. cement capacity. Forty-six cement kilns were operated and one kiln remained idle in 1976. Thirty-six kilns used the wet process, whereas 11 utilized the dry process for cement production. Raw materials consumed by the cement industry included significant quantities of limestone, cement rock, marl, gypsum, clay, and sand, and minor amounts of other raw materials.

Fuel consumption in the Texas cement industry in 1976 included natural gas (41.4 MMcf), fuel oil (77,000 barrels), and coal. Coal usage increased nearly 300% in 1976 as compared with 1975 consumption, reflecting a growing trend toward utilization of coal for firing cement kilns. Of total energy consumed in the Texas cement industry, coal accounted for over 11% in 1976 compared with 3% in 1975.

Centex Corp. announced plans to build a \$32 million cement plant near Buda in Hays County. This dry-process, single-kiln facility would have an annual capacity of 2.5 million barrels and was intended to replace Centex Corp.'s 1.5-million-barrels-per-year plant at Corpus Christi. This latter facility was being considered for conversion to lime production. The new Buda plant was scheduled for operation in 1978; construction began in the summer of 1976.

Clays.—In 1976, overall production of clays dropped continuing a downward trend following the record output in 1973. Value of clays produced, however, rose slightly as a result of a 15% increase in average value per ton. Forty-four companies reported operations at 99 pits in 1976. Clay was produced in 40 counties.

A third consecutive year of production decline was largely the result of an almost 10% drop in output of common clay and shale. Ball clay, bentonite, and kaolin production also declined in 1976. Increases in production were realized only for fire clay and fuller's earth (attapulgitite). Ball clay, bentonite, and fire clay declined in value of output, whereas all other clay types increased in value of output because of unit value increases.

Common clay and shale was produced by 37 companies operating 90 pits in 34 counties. Production of common clay and shale accounted for 95% of the State's total clay output in 1976. Despite the decline in production of common clay and shale, value of output rose slightly to \$7.6 million. Production from Eastland, Harris, Navarro, and Rusk Counties accounted for nearly 31% of Texas' total output of common clay and shale. Principal uses of common clay and shale in 1976 were in production of lightweight aggregate, cement, and heavy clay products (common brick, face brick, sewer pipe, structural tile, and others).

Table 16.—Texas: Clays sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Year	Ball clay		Bentonite		Fire clay		Common clay and shale		Total ¹	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1972 -----	W	W	88	1,128	89	684	4,894	7,872	5,175	11,554
1973 -----	W	W	85	802	87	689	5,330	8,951	5,667	18,115
1974 -----	41	329	69	881	41	316	5,046	8,365	5,315	18,677
1975 -----	55	467	W	W	34	271	3,995	7,594	4,248	18,411
1976 -----	16	109	39	850	54	260	3,597	7,628	23,706	28,847

W Withheld to avoid disclosing company proprietary data; included in "Total."

¹ Includes fuller's earth, kaolin, and data indicated by symbol W.

² Excludes fuller's earth and kaolin.

Kaolin production dropped 15%, but value rose sharply owing to a 112% increase in value per ton. Only one company reported production in 1976, producing kaolin from a single pit in Limestone County. Uses included filler or extender in paint, fertilizer, fiberglass, rubber, and animal feed, as an additive in portland cement, and for manufacture of sanitary ware.

Fire clay was produced for firebrick and other refractory materials in Texas in 1976. Production rose over 58% despite a sharp drop in average value. Four companies operated nine clay pits in Bastrop, Cherokee, Henderson, and Wood Counties.

Bentonite production declined in 1976, in both quantity and value compared with the 1975 figure. Bentonite was produced by three companies operating several pits in Fayette and Walker Counties. Texas bentonite was used primarily as an additive for well-drilling mud and as a filtering and decolorizing agent for vegetable and mineral oils.

Fuller's earth (attapulgite) was produced at one locality in Fayette County in 1976. Production increased slightly over the 1975 output, and average value rose over 16%. Fuller's earth was used to manufacture granules for absorbing oil and grease and pet wastes.

Six pits were worked by two companies in Cherokee and Rusk Counties in 1976 for the production of ball clay, which was used for face brick and for crockery and earthenware. Ball clay production dropped over 71% in 1976, and the value of ball clay production declined over 76%.

Fluorspar.—D & F Minerals Co. operated a fluorspar mine in the Christmas

Mountains near Big Bend National Park in Brewster County. Production of metallurgical-grade ore from La Mina Paisano increased 15% over the 1975 output. Value rose almost 22% in 1976. La Mina Paisano is an open pit mine to which underground operations have been added.

Fluorspar mined in the Republic of Mexico was processed at plants in Brownsville, Eagle Pass, and Marathon. Fluorspar from the Texas mine was processed in Marathon.

Graphite.—Domestic production of natural graphite for the United States in 1976 came entirely from a single open pit mine in Texas. Southwestern Graphite Co. operated the mine for the production of small-flake crystalline graphite from Precambrian age metamorphic rocks in Burnet County.

Graphite production rose over 15% in 1976, and sales increased over 33%. Value of graphite sold increased 46% in 1976 as compared with the 1975 value.

Gypsum.—Reflecting the general improvement of the Nation's economy and, in particular, the construction industries in 1976, gypsum production in Texas showed marked gains, approaching the record outputs of crude and calcined gypsum in 1972 and 1973. Production of crude gypsum increased nearly 40% and value of crude output increased nearly 48% compared with the 1975 figures. Calcined gypsum production and value increased 30% and 39%, respectively, in 1976. Average value of crude gypsum rose about 6% to \$4.13 per ton, and average value of calcined gypsum increased nearly 7% to \$24.62 per ton.

Seven companies operated seven surface mines for the production of crude gypsum

in 1976. Crude gypsum was used in portland cement as a retarder and was also used for agricultural applications. Production was reported from six counties—Nolan, Hardeman, Stonewall, and Fisher in north Texas; Gillespie in central Texas; and Hudspeth in west Texas.

Approximately 75% of the crude gypsum produced in Texas is calcined for manufacturing gypsum-based prefabricated building products, such as wallboard and lath, and building plasters. Six calcining plants were active in Texas in 1976. One operation used crude gypsum ore produced outside Texas. Calcining plants are located in Fisher, Hardeman, Harris, and Nolan Counties.

The Temple-Eastex, Inc., calcining plant in Irving, which processed Oklahoma gypsum for a variety of gypsum products, ceased operations.

Lime.—Despite a second straight year of decline in output, Texas ranked fifth in the Nation in lime production, accounting for 7% of U.S. output. Texas lime

production dropped over 16%, and value of production slumped almost 5%. Average unit value rose to \$30.22 in 1976 from the 1975 average price of \$26.62.

Quicklime accounted for 58% of Texas lime production; the remainder was hydrated lime. Uses of lime in 1976 included soil stabilization, paper and pulp processing, aluminum and bauxite processing, water purification, electric steel furnaces, oil well drilling, sewage treatment, and several others.

Twelve companies operated lime plants in 11 counties. Leading producers included PPG Industries, Inc., Nueces County; Austin White Lime Co., Travis County, and Texas Lime Co., Johnson County. Raw material used to make lime was primarily high-calcium limestone.

Chemical Lime, Inc., announced plans to install a new kiln with a daily capacity of 450 to 750 tons. The 340-foot kiln would burn a mixture of Texas lignite and natural gas. Construction started in 1976 and was due to be completed in mid-1977.

Table 17.—Texas: Lime sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Soil stabilization -----	518	11,940	490	13,570
Paper and pulp -----	101	2,884	149	4,727
Aluminum and bauxite -----	W	W	123	3,975
Water purification -----	124	3,508	109	3,196
Steel, electric -----	107	3,009	103	3,313
Oil well drilling -----	13	378	17	513
Sewage treatment -----	114	3,201	17	481
Mason's lime -----	14	331	14	385
Acid mine water -----	--	--	13	375
Petroleum refining -----	9	243	6	180
Other uses ¹ -----	736	20,740	416	13,269
Total ² -----	1,735	46,179	1,455	43,983

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

¹ Includes alkalis, open-hearth steel furnaces, petrochemicals, chrome, sugar refining, magnesium metal, copper ore concentration (1976), insecticides, other construction lime, glass, other metallurgy, rubber, paint, food and food byproducts, other chemical uses, sulfur removal (1976), agriculture, finishing lime (1976), wire drawing, BOF steel furnaces (1975), and uses indicated by symbol W.

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

Perlite (Expanded).—Out-of-State perlite was processed by seven companies operating in Dallas, Harris, Nolan, Bexar, and Comal Counties. No perlite has been mined in Texas since 1967.

Production and sales of expanded perlite were down in 1976 compared with the 1975 figures, but due to a 52% rise in

average value per ton, total value of perlite sold increased nearly 50% to \$3.9 million. Perlite expanded in Texas was sold mainly for use as a filter aid; other uses included concrete aggregate, plaster aggregate, horticultural and agricultural applications, insulation products, and miscellaneous fillers.

Salt.—In 1976 Texas ranked second in the Nation in production of salt. Over 95% of the salt produced in the State was salt in brine, with rock salt comprising the remainder. Brine was produced from salt domes along the gulf coast in Brazoria, Chambers, Duval, Harris, Jefferson, and Matagorda Counties and from subsurface salt beds in the west Texas counties of Hutchinson, Ward, and Yoakum. Rock salt was mined in two shallow salt domes in Harris and Van Zandt Counties. Evaporated salt was produced by the vacuum-pan process at plants in Fort Bend and Van Zandt Counties.

Table 18.—Texas: Salt sold or used by producers
(Thousand short tons and thousand dollars)

Year	Quantity	Value
1972	9,744	36,544
1973	10,354	45,350
1974	11,379	51,296
1975	8,560	42,119
1976	9,718	48,875

Salt production and sales in 1976 increased by over 13% compared with the 1975 figures. Value of salt sold increased more than 16% as the average value of salt rose from \$4.92 to \$5.03 per ton. Salt was used primarily in the chemical industry for a wide variety of products and processes, for preparation and preservation of food-stuffs, for water softeners, and for road deicing.

Sand and Gravel.—As the construction industry regained strength within the improving economy, Texas production of sand and gravel climbed to record levels—47.8 million tons valued at over \$103 million. Texas ranked within the top five States in the Nation in sand and gravel production. Production and value for sand and gravel in Texas in 1976 increased 24% and 18%, respectively, compared with the 1975 data. In 1976, 196 companies reported operations at 252 localities in 87 counties. The five leading counties for sand and gravel production were Colorado, Dallas, Victoria, Tarrant, and Harris; these counties accounted for 50% of the State's output.

Table 19.—Texas: Sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	26,607	\$43,467	\$1.63
Gravel	19,961	51,026	2.56
Total ¹	46,571	94,496	2.03
Industrial sand	1,277	8,721	6.83
Grand total	47,848	103,217	2.16

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

Table 20.—Texas: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.)--	23,978	\$53,272	\$2.22
Concrete products (cement blocks, bricks, pipe, etc.) --	3,359	7,734	2.30
Asphaltic concrete aggregates and other bituminous mixtures -----	4,736	10,805	2.28
Roadbase and coverings -----	6,251	11,823	1.89
Fill -----	7,048	7,984	1.13
Other uses -----	1,197	2,370	2.40
Total ¹ -----	46,571	94,496	2.03

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

Construction sand and gravel production increased approximately 24% in 1976; value also increased over 1975 figures. Commercial distribution of sand and gravel accounted for 85% of the total production, and government contracts accounted for the remainder. Processed sand and gravel represented 87% of the total production of construction sand and gravel and was used for concrete aggregate, bituminous paving, roadbase, and fill. Unprocessed sand and gravel was used primarily for fill and roadbase.

Industrial sand production dropped 3% in 1976, and value declined almost 21%. Ten companies worked 12 operations. All industrial sand production was used for molding, blast, oil (hydrofracturing), filter, glass, and other applications.

Leading producers of construction sand and gravel in 1976 included Gifford-Hill & Co., Inc., Lone Star Industries, Inc., Thorstenberg Materials Co., and Texas Industries, Inc. These four companies produced 29% of the State's output. Leading industrial sand producers were Dresser Industries, Inc., Texas Mining Co., and Pennsylvania Glass Sand Corp.

Oglebay Norton Co. purchased CX Products Corp.'s industrial sand operation near Brady in McCulloch County.

Sodium Sulfate (Natural).—Ozark-Ma-

honing Co. operated two plants, one each in Gaines and Terry Counties, for the production of natural sodium sulfate. Output of the Brownfield and Seagraves plants rose 9% in 1976 and value increased over 27% compared with the 1975 figures.

Sodium sulfate was recovered from shallow subterranean brines and processed into salt cake. Natural sodium sulfate was used in the pulp and paper industry, for detergent production, and in glassmaking.

Stone.—Texas ranked third in the Nation in total crushed stone production. Both production and value of crushed stone in 1976 declined approximately 5%. Eighty-seven companies produced crushed or broken stone at 221 quarries in 1976. Limestone, produced at 171 quarries, accounted for 94% of crushed stone production and was used for a wide variety of applications, including roadbase, concrete aggregate, cement manufacturing, bituminous aggregate, other aggregate, surface treatment aggregate, lime manufacturing, railroad ballast, riprap and jetty stone, whiting, chemicals, filler, and flux stone. Other raw materials produced for crushed and broken stone included granite, marble, marl, sandstone, shell, and traprock. Output of sandstone, shell, and traprock declined sharply in 1976, but granite, marl, and marble production increased.

Table 21.—Texas: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone	23,705	31,983	22,020	33,220
Cement manufacture	9,215	15,073	8,572	12,330
Concrete aggregate	7,020	13,576	6,737	14,180
Roadstone	3,623	6,010	4,730	8,293
Bituminous aggregate	4,274	14,562	3,386	9,969
Surface treatment aggregate	3,014	8,077	3,221	7,888
Lime manufacture ²	2,481	4,489	2,004	3,960
Railroad ballast	941	1,678	1,253	2,162
Riprap and jetty stone	826	1,954	533	1,222
Agricultural limestone	242	381	348	558
Flux stone	362	1,242	298	730
Roofing granules	133	560	201	652
Other filler	32	240	147	820
Macadam aggregate	404	616	129	181
Terrazzo and exposed aggregate	76	424	116	948
Mineral food	50	204	101	407
Whiting	138	1,000	W	W
Mine dusting	--	--	56	112
Glass	19	90	--	--
Other uses ³	1,408	2,232	984	2,233
Total⁴	57,964	104,390	54,841	99,816

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

¹ Includes limestone, shell, sandstone, marl, traprock, marble, granite, and miscellaneous stone (1975).

² Includes stone used in chemical stone, alkalies, sugar refining, and dead-burned dolomite (1975).

³ Includes chemicals, waste material, asphalt filler, filter stone, sulfur dioxide, and uses indicated by symbol W.

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

Crushed stone production occurred in 80 counties, led by Bexar, Wise, and Williamson. Leading crushed stone producers were Texas Crushed Stone Co., Parker Bros. & Co., Inc., and McDonough Bros., Inc. Twelve quarries produced almost 45% of the State's entire crushed stone production.

Dimension stone was produced by 7 companies operating 10 quarries. Both limestone and granite were produced for dimension stone; limestone was used mainly for rough blocks and flagging, and granite was used for monumental stone and cut stone. Other uses of Texas dimension stone included house-stone veneer and sawed stone. Dimension stone output in Texas dropped 30% in 1976, whereas the average value increased more than 20%, reflecting the greater proportion of high-unit-value granite output as compared to low-unit-value limestone output. The value of granite dimension stone is about 14 times the value of limestone on a per-ton basis.

Sulfur.—Production of native sulfur from Frasch mines declined for the second straight year in 1976, but sales of Frasch

sulfur rose slightly. Native sulfur was recovered by the Frasch process from salt domes along the gulf coast in five localities in Fort Bend, Jefferson, Liberty, and Wharton Counties. Sulfur-bearing caprocks were mined at Long Point, Spindletop, Fannett, Moss Bluff, and Boling domes. Sulfur-bearing strata of Permian age in west Texas were produced in three localities in Culberson and Pecos Counties. Texas producers of Frasch sulfur include Texasgulf, Inc., Jefferson Lake Sulphur Co., Duval Corp., and Farmland Industries, Inc.

Fifty-three operations processed natural gas and crude oil to recover sulfur in 29 counties. Harris, Van Zandt, Jefferson, and Cass Counties accounted for 58% of the State's recovered sulfur output. Sales of recovered sulfur were up more than 9% to 872,178 long tons, and value of recovered sulfur sold rose more than 18% to \$34.4 million. Average value per long ton of recovered sulfur increased from \$36.52 in 1975 to \$39.44 in 1976.

Table 22.—Texas: Sulfur produced and shipped from Frasch mines

(Thousand long tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1972 -----	3,755	3,847	W
1973 -----	4,294	4,109	W
1974 -----	4,593	4,473	W
1975 -----	4,141	3,406	W
1976 -----	3,777	3,415	W

W Withheld to avoid disclosing company proprietary data.

Texasgulf, Inc., suspended Frasch sulfur production at its Spindletop dome facility in early 1976, citing declining reserves and high production costs. Frasch sulfur production first began at Spindletop in 1952. Texasgulf's new Comanche Creek facility in Pecos County went into full production in February 1976.

Talc.—Production of crude talc increased sharply in 1976 to almost 200,000 tons, or 54% more than the 1975 output. Value of crude ore mined increased more than 34% in 1976 to just over \$1 million. Ground talc production and sales more than doubled to over 143,000 tons valued at \$3.4 million. Average price per ton was \$24.14, down slightly from the 1975 value.

Talc was mined in six open pits in Hudspeth and Culberson Counties. Talc was used as a filler or extender in a variety of products, including paint, joint-cement compound, acoustical ceiling, asphalt-based materials, ceramics, textiles, and rubber dusting.

Vermiculite.—Crude vermiculite mined outside Texas was exfoliated in three plants in Bexar, Dallas, and Harris Counties. W. R. Grace & Co. and Vermiculite Products, Inc., produced exfoliated vermiculite for use in concrete aggregate, fireproofing, soil conditioning, other horticultural applications, insulating materials, and plaster aggregate. Sales of exfoliated vermiculite rose 1% in 1976. Value of vermiculite sold, however, increased more than 16% owing to a sharp rise in average value per ton.

In late 1976, Volite, Inc., was preparing to reopen a vermiculite mine in Llano County.

METALS

In 1976, iron, magnesium, and uranium were the only metallic minerals mined in Texas. These metallic minerals, along with other ores and concentrates from Texas, other States, and foreign countries, were treated by a diverse primary-metal-processing industry. Primary metal production was supplemented by metal recovered from scrap. Tables 23 and 24 list the primary metal smelters, refineries, and reduction plants and other facilities that reclaim scrap and other secondary materials.

Aluminum.—Smelter output of primary aluminum decreased for the second year in a row, dropping about 10% below the 1975 output.

Alcoa began aluminum production at its Anderson County Works near Palestine in east Texas. Dedication ceremonies were held in July 1976. The Anderson County Works employs a new Alcoa smelting process that requires considerably less energy to produce aluminum.

Antimony.—Antimony ore from Mexico was treated at the Laredo smelter of NL Industries, Inc. Smelter output was about 13% higher than in 1975.

Cadmium.—Cadmium was recovered as a byproduct at the Corpus Christi zinc smelter of ASARCO, Inc. Cadmium experienced a solid recovery from the depressed markets of 1974–75 as production rose 361%, and value increased 282% over that of 1975.

Copper.—Production of smelter and refined copper increased about 100%. Most of the increase can be attributed to ASARCO, Inc.'s new 420,000-ton-per-year Amarillo refinery, which came onstream during the last quarter of 1975. The copper ores and concentrates continued to be smelted at the El Paso metallurgical works of ASARCO, Inc. Blister and anode copper produced at the El Paso smelters and from smelters in other States were refined at the Phelps Dodge Refining Corp. refinery in El Paso and the ASARCO, Inc., refinery in Amarillo.

Gold and Silver.—ASARCO, Inc., continued to recover gold and silver as by-products at its electrolytic copper refinery in Amarillo.

Iron Ore.—Brown iron ore (limonite and siderite) was mined from open pits in Cass, Morris, Cherokee, and Nacogdoches

Counties. Output of iron ore was down about 6%, but the value was up 6%. The ore was used in the production of pig iron and cement.

Lead.—Primary lead was recovered at ASARCO, Inc.'s metallurgical complex in El Paso. Ores and concentrates were imported from other States and Mexico.

Magnesium.—Two companies recovered magnesium chloride from seawater and from brine wells for the production of magnesium metal and compounds. Output and value of the metal and compounds were substantially lower than in 1975.

Manganese.—Imported feedstocks were used at the Tenn-Tex Alloy Corp. of Houston to produce ferrous manganese and silicomanganese.

Tin.—Gulf Chemical & Metallurgical Corp. continued to operate the only primary tin smelter in the United States at Texas City. Most of the feedstock for the smelter was tin ores from Bolivia.

Uranium.—Increased production from in situ leach projects supplemented the output from Conoco's Conquista mill and resulted in a slight gain in total output of uranium in 1976. Unit value was up significantly over that of 1975.

United States Steel Corp. acquired the controlling interests in the Clay West and Burns in situ leach projects in Live Oak County. Niagara-Mohawk Power Corp. also acquired an interest in the Clay West project.

Union Carbide Corp. began production from the Palangana in situ leach project during the first quarter of the year.

Wyoming Minerals was constructing plant facilities near Ray Point in Live Oak County to convert the Lamprecht pilot in situ leach project to a commercial-scale operation. The company also continued to operate an in situ leach test near Bruni in Webb County.

Mobil Oil Corp. continued experimental tests at its O'Hern in situ leach site near Bruni in Webb County.

Solution Engineering filed an application with the Texas Water Quality Board to

solution-mine the abandoned Susquehanna-Western tailing ponds near Falls City in Karnes County. Operations are scheduled to begin in 1978.

Intercontinental Energy Corp. began an in situ leach operation at the Pawnee site in Bee County.

Chevron Oil Co. announced plans to construct a 3,000-ton-per-day acid leach mill between Panna Maria and Hobson about 50 miles southeast of San Antonio. Mill construction and mining operations will begin in 1977 with mill startup in 1978.

In late 1976, Exxon USA filed an application with the TRRC for a surface-mining permit to reopen the Felder mine in Live Oak County.

Texas continued to be an attractive target for uranium exploration in 1976, ranking third in total exploration and development drilling with 8.8% of the U.S. total. Although most of the drilling activity was in the south Texas coastal plains, some exploration drilling was in the trans-Pecos and west Texas areas. Total footage drilled was 2,990,000 feet, down 9.8% from 1975. In 1976, land held by companies for uranium exploration and mining was 676,000 acres, up 8.7% over 1975, reversing a downward trend that had prevailed since 1974.

ERDA provides estimates of uranium reserves based on price per pound of U_3O_8 that reflect changes in recovery costs and technology, as well as changes in the resource base. At yearend 1976, ERDA estimated the proved reserves of uranium oxide (U_3O_8) in Texas to be 7,300, 29,000, and 44,000 tons at prices of \$10, \$15, and \$30 per pound, respectively. Texas ranked third nationally in proved uranium reserves based on either the \$15- or \$30-per-pound price.

Zinc.—Zinc production continued a 3-year decline, dropping about 14% below the 1975 output. Part of the production loss can be attributed to the closing of the last horizontal retort smelter in May 1975. This closing left ASARCO's Corpus Christi electrolytic facility as the only operating primary zinc smelter in the State.

Table 23.—Texas: Smelters, refineries, and reduction plants in 1976

Product, company, and plant	County	Material treated
Aluminum:		
Aluminum Co. of America:		
Point Comfort (alumina) -----	Calhoun -----	Bauxite.
Point Comfort (reduction) -----	do -----	Alumina.
Rockdale (reduction) -----	Milam -----	Do.
Anderson County (reduction) -----	Anderson -----	Do.
Reynolds Metals Co.:		
Sherwin works (alumina) -----	San Patricio -----	Bauxite.
San Patricio (reduction) -----	do -----	Alumina.
Antimony:		
NL Industries, Inc.:		
Laredo smelter -----	Webb -----	Ore.
Cadmium:		
ASARCO, Inc.:		
Corpus Christi, electrolytic -----	Nueces -----	Flue dust.
Copper:		
ASARCO, Inc.:		
Amarillo refinery -----	Potter -----	Bliester and anode.
El Paso smelter -----	El Paso -----	Ore and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery -----	do -----	Bliester and anode.
Iron:		
Lone Star Steel Co.:		
Daingerfield plant -----	Morris -----	Ore and scrap.
Armco Steel Corp.:		
Houston plant -----	Harris -----	Do.
United States Steel Corp.:		
Baytown plant -----	Chambers -----	Do.
Lead:		
ASARCO, Inc.:		
El Paso smelter -----	El Paso -----	Ore and concentrates.
Magnesium:		
The Dow Chemical Co.:		
Freeport plants, electrolytic -----	Brazoria -----	Seawater.
American Magnesium Co.:		
Snyder plant, electrolytic -----	Scurry -----	Brine.
Manganese:		
Tenn-Tex Alloy Corp -----		
	Harris -----	Ore.
Sodium:		
Ethyl Corp -----		
	do -----	Salt.
Tin:		
Gulf Chemical & Metallurgical Co.:		
Texas City smelter -----	Galveston -----	Ore.
Tungsten:		
Gulf Chemical & Metallurgical Co.:		
Texas City smelter -----	do -----	Do.
NL Industries, Inc.:		
Laredo plant -----	Webb -----	Do.
Zinc:		
ASARCO, Inc.:		
Corpus Christi electrolytic -----	Nueces -----	Ore and concentrates.
El Paso fuming plant -----	El Paso -----	Dusts and residues.

Table 24.—Texas: Secondary metal recovery plants

County and company	Material	Products
Austin: Schindler Bros. Steel Co	Steel scrap	Reinforced steel bars.
Brazoria: Texas Reduction Corp	Aluminum scrap	Alloyed aluminum ingots.
Dallas:		
Abasco, Inc	do	Aluminum ingots, dioxiding bars and shot.
ASARCO, Inc	Lead and zinc scrap	Lead and zinc ingots, pigs, alloys.
Dixie Industries, Inc	Lead scrap	Lead pigs, alloys, chemicals.
NL Industries, Inc., Metals Div.	Battery plates	Lead products.
Okon's Iron & Metal Co	Solder and lead scrap	Lead pigs and ingots.
Southern Lead Co	Battery plates	Lead pigs and alloys.
El Paso: Border Steel Mills, Inc	Steel scrap	Steel shapes and reinforcing bars.
Ellis: Chaparall Steel Co	do	Do.
Gregg: Marathon-LeTourneau Co	do	Heavy mobile equipment.
Guadalupe: Structural Metals, Inc	do	Structural-steel reinforcing bars.
Harris:		
A&B Metal & Smelting Co	Aluminum and lead scrap	Lead pigs, ingots, aluminum ingots, alloys.
Federated Metals	Various metals	Lead products, alloys of copper, lead, zinc, magnesium, tin.
Gulf Reduction Corp	Aluminum and zinc scrap	Aluminum and zinc ingots, alloys.
Houston Fishing Tackle Co	Soft lead scrap	Lead products.
Houston Lead Co	Lead scrap	Lead pigs, ingots, alloys.
Lead Products, Inc	do	Do.
Newell Metals, Inc	Zinc scrap	Zinc dust.
Proler International Corp	Aluminum and zinc scrap	Aluminum and zinc ingots.
Southwest Saw Corp	Steel scrap	Steel alloys.
Sterling Type, Rule and Metals Co.	Type metal	Type metal.
Vulcan Materials Co	Tinned scrap	Refined tin and baled detinned steel.
Jefferson:		
Georgetown Texas Steel Co	Steel scrap	Steel rods and shapes.
Smith: Tyler Pipe Industries, Inc.	do	Pipe and pipe fittings.
Tarrant:		
National Metal & Smelting Co.	Battery lead and aluminum scrap.	Lead pigs, ingots, battery metal, aluminum ingots.
Texas Steel Co	Steel scrap	Carbon and alloy steel bars and shapes, reinforcing bars.

Table 25.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt (native):			
Uvalde Rock Asphalt Co --	Box 531 San Antonio, Tex. 78206	Quarry and plant	Uvalde.
White's Uvalde Mines, Inc.	Box 499 San Antonio, Tex. 78206	---do-----	Do.
Barite:			
Dresser Industries, Inc ----	Box 6504 Houston, Tex. 77005	Grinding plant ----	Cameron and Galveston.
Milwhite Co., Inc -----	Box 15038 Houston, Tex. 77020	---do-----	Cameron and Harris.
NL Industries, Inc -----	Box 1675 Houston, Tex. 77001	---do-----	Nueces.
Carbon black:			
Ashland Chemical Co -----	Box 1503 Houston, Tex. 77005	Furnace plant ----	Aransas and Wheeler.
Cabot Corp -----	125 High St. Boston, Mass. 02110	---do-----	Gray and Howard.
Columbian Carbon Co., a division of Cities Service Co.	3200 West Market Akron, Ohio 44313	---do-----	Montgomery.
Continental Carbon Co ----	Box 22085 Houston, Tex. 77027	---do-----	Moore.
J. M. Huber Corp -----	Box 831 Borger, Tex. 79066	---do-----	Harris and Hutchinson.
Phillips Petroleum Co ----	Adams Bldg. Bartlesville, Okla. 74004	---do-----	Hutchinson and Orange.
Sid Richardson Carbon & Gasoline Co.	1105 Fort Worth National Bank Bldg. Fort Worth, Tex. 76102	---do-----	Howard.
Cement:			
Alpha Portland Cement Co.	15 South 3d St. Easton, Pa. 18042	Quarry and plant	Orange.
Capitol Aggregates, Inc ---	Route 13, Box 412 San Antonio, Tex. 78209	---do-----	Bexar.
Centex Cement Corp -----	Box 9294 Corpus Christi, Tex. 78408	---do-----	Nueces.
General Portland, Inc.-----	2800 Republic Bank Tower Dallas, Tex. 75201	---do-----	Dallas, Harris, Tarrant.
Gifford-Hill & Co., Inc ----	Box 520 Midlothian, Tex. 76065	---do-----	Ellis.
Gulf Coast Portland Cement Co., a division of McDonough Co.	Box 262 Houston, Tex. 77001	---do-----	Harris.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	Box 47327 Dallas, Tex. 75247	---do-----	Harris and Nolan.
Lone Star Industries, Inc --	420 Ideal Cement Bldg. Denver, Colo. 80202	---do-----	Do.
Longhorn Div., Kaiser Cement & Gypsum Corp.	Kaiser Center 300 Lakeside Dr. Oakland, Calif. 94612	---do-----	Bexar.
San Antonio Portland Cement Co.	Box 6925 San Antonio, Tex. 78209	---do-----	Do.
Southwestern Portland Cement Co.	Box 392 El Paso, Tex. 79943	---do-----	Ector, El Paso, Potter.
Texas Industries, Inc -----	Box 146 Midlothian, Tex. 76065	---do-----	Ellis.
United States Steel Corp., Universal Atlas Cement Div.	600 Grant St. Pittsburgh, Pa. 15230	---do-----	McLennan.
Clays:			
Aeme Brick Co., a division of Justin Industries, Inc.	Box 425 Forth Worth, Tex. 76101	Mine and plant ---	Denton, Guadalupe, Nacog- doches, Van Zandt, Wise.
Balcones Minerals Corp ----	Box B Flatonis, Tex. 78941	---do-----	Fayette.
Dresser Industries, Inc ----	601 Jefferson Houston, Tex. 77002	---do-----	Angelina and Limestone.
Elgin Butler Brick Co ----	Box 1947 Austin, Tex. 78767	---do-----	Bastrop.
Featherlite Corp -----	Box 141 Ranger, Tex. 76470	---do-----	Eastland.
General Portland, Inc -----	Box 2698 Dallas, Tex. 75201	---do-----	Dallas and Limestone.
General Refractories Co ---	1520 Locust St. Philadelphia, Pa. 19102	---do-----	Cherokee.

Table 25.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Clay and shale—Continued			
Gulf Coast Portland Cement Co., a division of McDonough Co.	Box 262 Houston, Tex. 77001	Mine -----	Chambers.
Henderson Clay Products Co.	Box 1251 Henderson, Tex. 75652	Mine and plant ---	Rusk.
Lone Star Industries, Inc --	Box 47327 Dallas, Tex. 75247	Mine -----	Fisher and Harris.
Milwhite Co., Inc -----	Box 15038 Houston, Tex. 77020	Mine and plant ---	Fayette and Walker.
Southern Clay Products, Inc.	Box 44 Gonzales, Tex. 78629	---do -----	Angelina, Cherokee, Gonzales.
Texas Clay Products, Inc --	Box T Malakoff, Tex. 75148	---do -----	Henderson.
Texas Industries, Inc -----	8100 Carpenter Freeway Dallas, Tex. 75247	---do -----	Comanche, Dallas, Ellis, Fort Bend, Henderson, Marion, Van Zandt.
Coal (lignite):			
ICI United States, Inc ---	Box 790 Marshall, Tex. 75670	Strip mine -----	Harrison.
Industrial Generating Co --	Box 1111 Rockdale, Tex. 76567	---do -----	Milam.
Texas Utilities Generating Co.	Box 948 Fairfield, Tex. 75840	---do -----	Freestone.
Do -----	Box 1266 Mt. Pleasant, Tex. 75455	---do -----	Titus.
Do -----	Box 651 Tatum, Tex. 75691	---do -----	Panola.
Fluorspar:			
D & F Minerals Co -----	Box 75 Terlingua, Tex. 79852	Mine -----	Brewster.
Graphite:			
Southwestern Graphite Co -	Burnet, Tex. 78611 -----	Mine and mill ---	Burnet.
Gypsum:			
The Celotex Corp -----	1500 North Dale Mabry Tampa, Fla. 33607	Quarry and calcining plant.	Fisher.
The Flintkote Co -----	400 Westchester Ave. White Plains, N.Y. 10604	---do -----	Nolan.
Georgia-Pacific Corp -----	900 SW. 5th Ave. Portland, Ore. 97204	---do -----	Hardeman.
National Gypsum Co -----	325 Delaware Ave. Buffalo, N.Y. 14202	---do -----	Fisher.
United States Gypsum Co --	101 South Wacker Dr. Chicago, Ill. 60606	---do -----	Nolan.
Do -----	do -----	Plant -----	Harris.
Iron ore:			
Lone Star Steel Co -----	Box 12226 Dallas, Tex. 75225	Mine -----	Cass and Morris.
Tex-Iron, Inc -----	Cushing, Tex. 75760 -----	---do -----	Nacogdoches.
Lime:			
Aluminum Co. of America..	1028 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant -----	Calhoun.
Armco Steel Corp -----	Box 1367 Houston, Tex. 77001	---do -----	Harris.
Austin White Lime Co ---	General Delivery McNeil, Tex. 78651	---do -----	Travis.
Champion Papers, Inc ---	Box 872 Pasadena, Tex. 77501	---do -----	Harris.
The Dow Chemical Co ---	2020 Dow Center Midland, Mich. 48640	---do -----	Brazoria.
Eastex, Inc -----	Box 816 Silsbee, Tex. 77656	---do -----	Jasper.
Holly Sugar Corp -----	Drawer 1778 Hereford, Tex. 79045	---do -----	Deaf Smith.
McDonough Bros., Inc -----	Fredericksburg Rd. Route 8, Box 222 San Antonio, Tex. 78228	---do -----	Bexar.
PPG Industries, Inc -----	Box 4026 Corpus Christi, Tex. 78408	---do -----	Nueces.
Round Rock Lime Co ---	Box 218 Round Rock, Tex. 78664	---do -----	Hill.
Texas Lime Co -----	Box 851 Cleburne, Tex. 76031	---do -----	Johnson.
United States Gypsum Co -	101 South Wacker Dr. Chicago, Ill. 60606	---do -----	Comal.

Table 25.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Magnesium:			
American Magnesium Co	Route 1, Box 666 Snyder, Tex. 79549	Plant	Scurry.
Dow Chemical USA	2020 Dow Center Midland, Mich. 48640	do	Brazoria.
Magnesium compounds:			
Dow Chemical USA	2020 Dow Center Midland, Mich. 48640	do	Do.
A. P. Green Refractories, Co.	6315 Hwy. 332 East Freeport, Tex. 77541	do	Do.
Perlite:			
Filter Media, Inc	Box 19156 Houston, Tex. 77024	Expanding plant	Harris.
Perlite of Houston, Inc	Box 8386 Houston, Tex. 77004	do	Do.
Sil-Flo Corp	Box 7086 Forth Worth, Tex. 76111	do	Dallas.
South Texas Perlite Co	Judson Rd. San Antonio, Tex. 78233	do	Bexar.
Texas Vermiculite Co	2651 Manila Dallas, Tex. 75212	do	Dallas.
United States Gypsum Co	101 South Wacker Dr. Chicago, Ill. 60606	do	Nolan.
Roofing granules:			
H. B. Reed & Co., Inc	8149 Kennedy Ave. Highland, Ind. 46322	Plant	Milam.
Salt:			
Diamond Shamrock Corp	300 Union Commerce Bldg. Cleveland, Ohio 44115	Brine wells	Chambers.
The Dow Chemical Co	Midland, Mich. 48640	do	Brazoria.
Morton Salt Co	110 North Wacker Dr. Chicago, Ill. 60606	Underground mine and brine wells.	Van Sandt.
PPG Industries, Inc	Box 4026 Corpus Christi, Tex. 77704	Brine wells	Duval.
Phillips Petroleum Co	Bartlesville, Okla. 74003	do	Hutchinson.
Texas Brine Corp	2000 West Loop South Houston, Tex. 77027	do	Harris, Jefferson, Matagorda.
United Salt Corp	do	Underground mine and brine wells.	Fort Bend and Harris.
Vulcan Materials Co	Box 1060 Denver City, Tex. 79323	Brine wells	Yoakum.
Sand and gravel:			
Capitol Aggregates, Inc	Route 13, Box 142 San Antonio, Tex. 78209	Stationary	Guadalupe and Travis.
Dresser Industries, Inc	Kosse, Tex. 76653	do	Limestone.
Fort Worth Sand & Gravel Co.	Box 400 Arlington, Tex. 76010	do	Dallas, Denton, Tarrant.
Gifford-Hill & Co., Inc	Box 47127 Dallas, Tex. 75247	do	Brazos, Colorado, Dallas, McLennan, Tarrant, Wichita.
Horton & Horton, Inc	Box 1669 Houston, Tex. 77001	Portable and dredge.	Colorado, Harris, Victoria.
Janes-Prentice, Inc	Box 2155 Austin, Tex. 78767	Stationary	Crosby.
Lone Star Industries, Inc	Box 47327 Dallas, Tex. 75247	do	Colorado and Denton.
Parker Bros. & Co., Inc	Box 107 Houston, Tex. 77001	Stationary and dredge.	Colorado and Harris.
The Fordyce Co	Box 1981 San Antonio, Tex. 78206	Stationary	Hidalgo and Victoria.
Thorstenberg Materials Co.	1435 Bank of the Southwest Bldg. Houston, Tex. 77002	Stationary and dredge.	Colorado and Harris.
Shell:			
Parker Bros. & Co., Inc	Box 107 Houston, Tex. 77001	Dredge	Calhoun.
Sodium (metallic):			
Ethyl Corp	Box 472 Pasadena, Tex. 77501	Plant	Harris.
Sodium sulfate (natural):			
Ozark-Mahoning Co	1870 South Boulder Tulsa, Okla. 74119	do	Gaines and Terry.
Stone:			
Barrett Industries	Box 21070 San Antonio, Tex. 78221	Quarry	Bexar.

Table 25.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
General Portland, Inc -----	2800 Republic Bank Tower Dallas, Tex. 75201	Quarry -----	Dallas, Tarrant, Wise.
Gifford-Hill & Co., Inc ----	Box 47127 Dallas, Tex. 75247	----do -----	Wise.
Lone Star Industries, Inc --	Box 47327 Dallas, Tex. 75247	----do -----	Burnet, Nolan, Wise.
Parker Bros. & Co., Inc --	Box 107 Houston, Tex. 77001	----do -----	Comal.
Texas Crushed Stone Co --	Box 9345 Austin, Tex. 78717	----do -----	Ilano and Williamson.
Texas Industries, Inc -----	Box 146 Midlothian, Tex. 76065	----do -----	Ellis and Wise.
White's Mines, Inc -----	Box 499 San Antonio, Tex. 78206	----do -----	Brown, Taylor, Uvalde.
Sulfur (native):			
Duval Corp -----	1906 First City National Bank Bldg. Houston, Tex. 77002	Frasch mine -----	Culberson.
Farmland Industries, Inc --	Box 850 Fort Stockton, Tex. 79735	----do -----	Pecos.
Jefferson Lake Sulfur Co --	Box 1185 Houston, Tex. 77001	----do -----	Fort Bend.
Texasgulf, Inc -----	200 Park Ave. New York, N.Y. 10017	----do -----	Fort Bend, Jefferson, Liberty, Pecos, Wharton.
Sulfur (byproduct):			
Amoco Production Co -----	Box 591 Tulsa, Okla. 74102	Secondary recovery	Andrews, Ector, Hockley, Van Zandt, Wood.
Cities Service Oil Co -----	Box 300 Tulsa, Okla. 74102	----do -----	Cochran, Dawson, Gaines, Van Zandt.
Getty Oil Co -----	Box 8 Scroggins, Tex. 75480	----do -----	Franklin and Freestone.
Gulf Oil Corp -----	Box 701 Port Arthur, Tex. 77640	----do -----	Jefferson.
Phillips Petroleum Co -----	Bartlesville, Okla. 74003	----do -----	Brazoria, Crane, Ector, Hutchinson.
Shell Oil Co -----	Box 2099 Houston, Tex. 77001	----do -----	Cass, Harris, Karnes.
Warren Petroleum Corp ---	Box 1589 Tulsa, Okla. 74101	----do -----	Crane, Hopkins, Karnes.
Talc and soapstone:			
Pioneer Talc Co., Inc -----	Chatsworth, Ga. 30705	Mine and plant	Hudspeth.
Southern Clay Products, Inc.	Box 44 Gonzales, Tex. 78629	Mine -----	Do.
Texas Talc Co., Inc -----	Box 17130 Dallas, Tex. 75217	----do -----	Do.
United Sierra, a division of Cyprus Mines Corp.	Box 1201 Trenton, N.J. 08606	----do -----	Do.
Westex Talc Co -----	Box 15038 Houston, Tex. 77020	Mine and plant	Culberson and Hudspeth.
Uranium:			
Continental Oil Co.— Pioneer Nuclear Corp.	Box 300 Falls City, Tex. 78113	Open pit mines and mill.	Karnes and Live Oak.
Intercontinental Energy Corp.	600 South Cherry Suite 135 Denver, Colo. 80202	Solution mines and plant.	Bee.
Mobil Oil Corp -----	Box 5444 Denver, Colo. 80217	----do -----	Webb.
United States Steel Corp --	600 Winnebago St. Corpus Christi, Tex. 78401	----do -----	Live Oak.
Union Carbide Corp -----	270 Park Ave. New York, N.Y. 12603	----do -----	Duval.
Wyoming Minerals -----	55 West 5th Ave. Denver, Colo. 80204	----do -----	Live Oak and Webb.
Vermiculite:			
Texas Vermiculite Co -----	2651 Manila Rd. Dallas, Tex. 75200	Exfoliating plant	Bexar and Dallas.
Vermiculite Products, Inc--	Box 7327 Houston, Tex. 77008	----do -----	Harris.
Volite, Inc -----	Box 122 Llano, Tex. 78643	Mine -----	Llano.

The Mineral Industry of Utah

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineral Survey, for collecting information on all minerals.

By William A. McKinney¹

The value of mineral production in Utah during 1976 was \$1,044 million, surpassing \$1 billion for the first time. This total is 8% higher than that of 1975, the previous record year. Increases were recorded in all three commodity groups—metals, nonmetals, and mineral fuels. The largest gain was recorded in the metals group.

Total value of the metals group rose 15% over that of 1975. All metal commodities except gold increased in value, with uranium and vanadium showing the most substantial gains. Although gold production was only 1% less than in 1975, the gold value decreased 23% because of lower prices. Copper accounted for 65% of the value of the metals group and 25% of the value of all minerals produced in Utah.

In the nonmetals group, increased production values were recorded for nine commodities. Sand, gravel, clays, fluorspar, phosphate rock, and potassium salts declined in value. Substantial increases in pumice, lime, sodium sulfate, and magnesium compounds raised total value of nonmetals 6% over that of 1975.

Production of mineral fuels increased 4% in total value. A 32% increase in coal value, accompanied by gains in natural gas and natural gas liquids, offset an 8% decrease in the value of crude petroleum and decreases in the values of asphalt and carbon dioxide. Crude petroleum and bituminous coal accounted for 48% of the value of all mineral production in Utah.

A total of 170 million tons of material was handled in the metals and nonmetals industries in 1976. This total included 49 million tons of ore, 119 million tons of waste, and 2 million tons of ore and waste from development activities. Material mined and moved at the surface consisted of 48 million tons of crude ore and 117 million tons of waste. In underground mining, 1.3 million tons of ore and 1.9 million tons of waste were handled.

The three major utility companies involved in the proposed 3,000-megawatt coal-burning Kaiparowits powerplant in Kane County canceled plans for this major energy-producing plant. Southern California Edison, San Diego Gas and Electric Co., and Arizona Public Service Co. abandoned plans for construction of the plant because of the high cost as a result of inflation and lawsuit threats by environmental groups. The total estimated cost of plant construction increased approximately 600% over original estimates made in November 1964, from \$500 million to \$3.5 billion.

Despite cancellation of the proposed powerplant project, the three companies will continue to hold leases in the Kaiparowits Plateau coalfield because the coal may be utilized for gasification, liquefaction, or for shipment to powerplants located in other areas. The leases cover 45,000 acres of Federal and State land containing low-sulfur coal reserves in ex-

¹ State Liaison Officer, Bureau of Mines, Salt Lake City, Utah.

Table 1.—Mineral production in Utah¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Carbon dioxide, natural -----thousand cubic feet--	108,941	\$8	21,875	\$2
Clays ² -----thousand short tons--	220	548	206	531
Coal (bituminous) -----do-----	6,961	138,134	7,967	182,712
Copper (recoverable content of ores, etc.) -----do-----	177,155	227,467	185,458	258,157
Fluorspar -----do-----	9,542	389	W	W
Gem stones -----do-----	NA	100	NA	105
Gold (recoverable content of ores, etc.) -----troy ounces--	189,620	30,622	187,318	23,475
Gypsum -----thousand short tons--	247	1,457	270	1,657
Iron ore (usable) -----do-----	1,334	10,399	W	W
Lead (recoverable content of ores, etc.) -----short tons--	12,679	5,452	16,297	7,529
Lime -----thousand short tons--	161	4,540	202	6,855
Natural gas -----million cubic feet--	55,354	26,570	57,416	28,995
Petroleum (crude) -----thousand 42-gallon barrels--	42,301	348,131	34,304	318,911
Pumice -----thousand short tons--	17	23	164	264
Salt -----do-----	631	7,717	705	10,090
Sand and gravel -----do-----	10,159	14,342	³ 10,547	³ 13,442
Silver (recoverable content of ores, etc.) -----thousand troy ounces--	2,822	12,472	3,134	13,633
Stone -----thousand short tons--	2,486	6,167	2,751	7,009
Zinc (recoverable content of ores, etc.) -----short tons--	19,640	15,319	22,481	16,636
Value of items that cannot be disclosed:				
Asphalt, beryllium concentrate, cement, clays (kaolin), magnesium compounds, molybdenum, natural gas liquids, phosphate rock, potassium salts, sand and gravel (industrial, 1976), sodium sulfate, tungsten concentrate, uranium, vanadium, and values indicated by symbol W ----	XX	116,550	XX	153,978
Total	XX	966,407	XX	1,043,981
Total 1967 constant dollars	XX	382,407	XX	^P 375,311

^P Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

² Excludes kaolin; included with "Value of items that cannot be disclosed."

³ Excludes industrial sand and gravel; included with "Value of items that cannot be disclosed."

cess of 1 billion tons, of which perhaps 500 million tons is recoverable.

The Utah Air Conservation Committee voted to permit Utah Power & Light Co. to operate three proposed power units in Emery County. The Committee was satisfied that the units as planned would meet the required clean air standards of the State. One unit would be constructed at Huntington adjacent to the existing plant, and two units would be built near Emery.

Phillips Petroleum Co. completed 8 geothermal wells in the Roosevelt Hot Springs area in Beaver County and planned to drill 16 more, subject to Federal approval. Company officials estimated that the area has the potential to provide 75 megawatts of power for a period of 50 years. Based on present studies, a plant

could be installed and in operation by 1981. Phillips is conducting preliminary talks with officials of Utah Power & Light Co. concerning possible utilization of the geothermal area.

The water level of Great Salt Lake continued to rise, creating potential problems for companies extracting salts from the lake. The principal problem was maintaining proper dikes to protect the evaporation ponds and plant equipment. The level of the lake on May 15, 1976, was 4,202 feet, which was the highest since May 15, 1928, when the level was 4,202.6 feet. During the past 10 years, the lake level has been rising at an average rate of 8 to 9 inches per year. If the rise continues at that rate for the next 3 years, the critical elevation of 4,205 feet will be reached, posing many problems for industry on the

Table 2.—Value of mineral production in Utah, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Beaver -----	\$176	W	Sand and gravel, stone.
Box Elder -----	2,116	\$2,468	Stone, sand and gravel, lime, salt, tungsten.
Cache -----	W	W	Sand and gravel, stone.
Carbon -----	81,694	90,249	Coal, petroleum, natural gas, carbon dioxide, sand and gravel.
Daggett -----	1,077	920	Natural gas, petroleum, stone.
Davis -----	1,340	2,083	Sand and gravel.
Duchesne -----	209,341	176,357	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Emery -----	W	82,532	Coal, uranium, natural gas, sand and gravel, vanadium.
Garfield -----	W	W	Petroleum, sand and gravel, stone.
Grand -----	11,500	11,852	Potassium salts, natural gas, petroleum, uranium, sand and gravel.
Iron -----	W	11,374	Iron ore, sand and gravel, pumice, silver, gold, lead, zinc.
Juab -----	627	930	Lead, silver, fluorspar, clays, gypsum, stone, gold, sand and gravel, copper.
Kane -----	251	149	Sand and gravel, stone.
Millard -----	W	W	Pumice, gypsum, sand and gravel, beryllium, silver, copper.
Morgan -----	W	W	Cement, stone, sand and gravel.
Piute -----	W	W	Clays, sand and gravel.
Rich -----	W	W	Phosphate rock.
Salt Lake -----	297,375	325,266	Copper, molybdenum, gold, cement, silver, sand and gravel, salt, lime, stone, clays.
San Juan -----	130,721	154,072	Petroleum, uranium, natural gas, vanadium, natural gas liquids.
Sanpete -----	1,601	1,856	Sand and gravel, gypsum, salt, clays.
Sevier -----	10,875	13,437	Coal, gypsum, salt, clays, sand and gravel.
Summit -----	17,258	29,987	Petroleum, zinc, lead, silver, natural gas, clays, copper, gold, stone.
Tooele -----	12,110	15,154	Lime, salt, potassium salts, stone, sand and gravel, magnesium compounds, tungsten.
Uintah -----	63,571	63,275	Petroleum, phosphate rock, asphalt, natural gas, sand and gravel, natural gas liquids, copper.
Utah -----	W	W	Zinc, silver, lead, gold, stone, sand and gravel, copper, clays, salt.
Wasatch -----	W	181	Sand and gravel, stone.
Washington -----	W	W	Sand and gravel, petroleum, stone.
Wayne -----	W	W	Sand and gravel.
Weber -----	13,720	13,183	Potassium salts, salt, sodium sulfate, asphalt, sand and gravel, magnesium compounds, clays.
Undistributed ² -----	111,056	48,650	
Total ³ -----	966,407	1,043,981	

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

¹ Values of petroleum and natural gas (1976) are based on an average price per barrel and cubic foot, respectively, for the State.

² Includes some sand and gravel 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.

lake and impairing the upstream discharge of the Jordan River, a link between Great Salt Lake and Utah Lake, 40 miles to the south.

Legislation and Government Programs.—The Bureau of Mines awarded five grants for metallurgical research, totaling \$125,000, to the University of Utah. The objectives of the grants were to (1) develop a system for modeling of the leaching of oxide copper ores, (2) determine the equilibrium thermodynamics and the adsorption and desorption kinetics of the reaction between gold and silver cyanide

complexes and activated carbon particles, (3) provide fundamental data on solvent extraction of copper from ammonia solutions, (4) evaluate native plants for vegetative stabilization of tailings from mineral-processing operations, and (5) develop a thermochemical model for sintering of lead concentrates.

The Utah Geological and Mineral Survey (UGMS) completed federally funded investigations of lead and zinc occurrences and iron ore deposits in Utah under the Minerals Availability System program. Another UGMS project, also funded by the

Table 3.—Indicators of Utah business activity

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	505.1	513.0	+1.6
Unemployment -----do-----	35	29	-17.1
Employment (nonagricultural):			
Mining -----do-----	13.3	13.9	+4.5
Manufacturing -----do-----	67.5	70.7	+4.7
Contract construction -----do-----	24.3	27.7	+14.0
Transportation and public utilities -----do-----	27.0	28.1	+4.1
Wholesale and retail trade -----do-----	104.4	112.0	+7.3
Finance, insurance, real estate -----do-----	19.7	20.6	+4.6
Services -----do-----	73.7	77.5	+5.2
Government -----do-----	110.3	112.3	+1.8
Total nonagricultural employment -----do-----	¹ 440.3	¹ 462.9	+5.1
Personal income:			
Total -----millions--	\$5,825	\$6,570	+12.8
Per capita -----do-----	\$4,843	\$5,350	+10.5
Construction activity:			
Number of private and public residential units			
authorized--	12,960	13,141	+40.0
Value of nonresidential construction -----millions--	\$126.8	\$154.0	+21.4
Value of State road contract awards -----do-----	\$62.5	\$55.0	-12.0
Shipments of portland and masonry cement to and within the State -----thousand short tons--	692	922	+33.2
Mineral production value:			
Total crude mineral value -----millions--	\$966.4	\$1,044.0	+8.0
Value per capita, resident population -----do-----	\$803	\$850	+5.9
Value per square mile -----do-----	\$11,381	\$12,294	+8.0

^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.

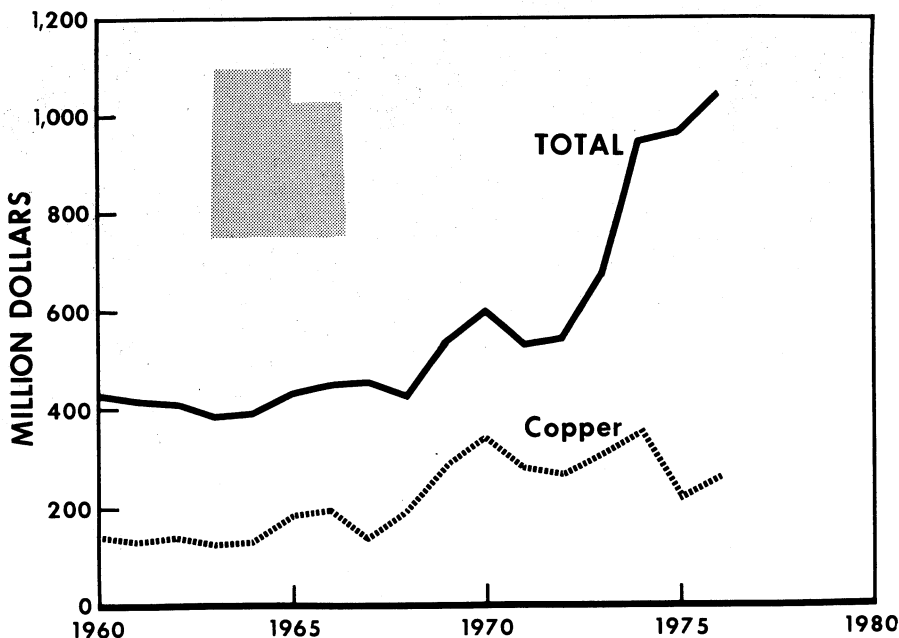


Figure 1.—Value of mine production of copper, and total value of mineral production in Utah.

Federal Bureau of Mines, to collect data on the methane content of Utah coals went into its second year.

The National Park Service developed a statement of management objectives for Capitol Reef National Park in Wayne County. The park boundaries enclose a total of 241,671 acres of land. Federal land totals 218,559 acres, and the balance consists of 21,410 acres of State land and 1,702 acres of private land. A large part of the Federal land would be classed as "proposed wilderness subzone," or "natural environment subzone." Most types of land development would not be permitted in either subzone. Approximately 35 small pockets of land within the park boundaries

are classified as "private development subzone," which are areas of conditional use permits granted by the National Park Service or are areas of State or private land with current development. Permits for development on Federal land tracts will not be renewed after expiration of present agreements. Four oil and gas permits in the park expire no later than 1980. Land in the "private development subzone" is principally State property with a small acreage of private land. The National Park Service hopes to eventually exchange Federal land elsewhere for the State land within the park and purchase all private land in the Park.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Asphalt and Related Bitumens.—Output from the State's two gilsonite-producing properties in Uintah County increased 9% in quantity but decreased 12% in value as a result of lower average price for this commodity.

Carbon Dioxide.—All production of carbon dioxide continued to come from one well in the Farnham Dome field, Carbon County, but output declined 80% compared with that of 1975. Value dropped 75%.

Coal (Bituminous).—Coal production during 1976 was principally from mines in Carbon, Emery, and Sevier Counties. Exploration was underway in other counties, and it is probable that coal will be produced from these areas in future years. Coal production in 1976 increased 14% in quantity and 32% in value, compared with that of 1975.

United States Fuel Co., a subsidiary of UV Industries, Inc., announced plans to enlarge its coal-producing operations in Carbon County as a result of a major new contract arranged with Nevada Power Co. Under terms of the contract, the fuel company will deliver 6.4 million to 8.1 million tons of coal to the Nevada Power Co. plant at Moapa, Nev., during the period January

1, 1977, to December 31, 1994. The coal will be extracted from the presently operated Hiawatha mine, or possibly in part from a new mine that may be opened by 1981, dependent upon additional contracts to supply coal to other buyers.

Valley Camp of Utah, Inc., began unit train shipments of coal from its Carbon County properties to Nevada Power Co.'s electric generating plant at Moapa, Nev. Two unit trains transport a total of approximately 8,000 tons per week of coal to the southern Nevada plant.

Soldier Creek Coal Co., a wholly owned subsidiary of California Portland Cement Co., began production at the Soldier Creek mine in the Book Cliffs field following an extensive rehabilitation project. The mine furnishes coal to cement plants owned by the parent company at Colton and Mojave, Calif., and Rillito, Ariz.

General Exploration Co. and Swisher Coal Co. of Price signed a contract to sell 13 million tons of coal from Swisher's Gordon Creek and Huntington Canyon properties to a major Gulf Coast utility over a 15-year period. Deliveries were to begin in 1978. The agreement provides for two successive 5-year renewals after the initial 15-year contract has been completed.

Table 4.—Utah: Bituminous coal production, by type of mine and county, in 1976
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines				Production (thousand short tons)				Value (thousands)
	Under-ground	Strip	Auger	Total	Under-ground	Strip	Auger	Total	
Carbon	14	--	--	14	3,733	--	--	3,733	\$89,937
Emery	9	--	--	9	3,191	--	--	3,191	W
Sevier	1	--	--	1	1,043	--	--	1,043	W
Undistributed	--	--	--	--	--	--	--	--	92,775
Total	24	--	--	24	7,967	--	--	7,967	182,712

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

Natural Gas.—The quantity of marketed natural gas was 57.4 billion cubic feet, an increase of 4% over that marketed in 1975. The average wellhead price increased from 48.0 cents per thousand cubic feet in 1975 to 50.5 cents per thousand cubic feet in 1976, equivalent to a total value of \$29 million for the marketed natural gas.

The State Division of Oil, Gas, and Mining² reported production of 77.1 billion cubic feet of natural gas, of which 20.4 billion cubic feet was injected into reservoirs for storage. San Juan County was the largest producer, with Duchesne and Uintah Counties in second and third place, respectively. The three counties accounted for 84% of the State's natural gas output.

Natural gas reserves estimated by the American Petroleum Institute (API) and the American Gas Association (AGA) totaled 0.83 trillion cubic feet. During 1975, reserves decreased by 88 billion cubic feet.

Five productive gas wells were completed during the year—four in Grand County and one in Carbon County.

Natural Gas Liquids.—Production of natural gas liquids increased 12% in quantity and 35% in value. Reserves of natural gas liquids estimated by API and AGA totaled 42.5 million barrels at yearend 1976, a decrease of 6.9 million barrels compared with 1975 figures.

Petroleum.—Production of crude petroleum during 1976 decreased 19% compared with that of 1975. Total value dropped 8%. Duchesne County was the most productive county, accounting for 50% of the crude petroleum. San Juan County was second with 29% of the total production. In third and fourth place were Uintah

and Summit Counties, respectively, with 14% and 4% of the State yield. Summit County surpassed Garfield County as a result of recent emergence of the new Pineview field.

The Bluebell field in Duchesne and Uintah Counties was the leading productive field with 8.9 million barrels of oil. The Greater Aneth field in San Juan County was second with 8.2 million barrels of oil, followed by the Altamont field in Duchesne County with 7.3 million barrels; Red Wash Unit, Uintah County, 2.1 million barrels; Cedar Rim field in Duchesne County, 1.4 million barrels; Upper Valley field in Garfield County, 1.2 million barrels; Wonsits Valley field in Uintah County, 1.2 million barrels; and Lisbon field, San Juan County, 1.0 million barrels of oil. These eight fields accounted for 91% of the oil produced in the State.

Proved crude oil reserves in Utah at yearend 1976 were 183.2 million barrels, a decrease of 25.1 million barrels compared with that of 1975.

Eight oil refineries in the State processed 44.8 million barrels of crude oil; Utah fields provided 18.4 million barrels and 26.3 million barrels were received from other States. Colorado provided 18.5 million barrels and Wyoming, 7.8 million barrels. Out-of-State shipments of Utah crude oil totaled 14.8 million barrels, of which 5.8 million went to California; 3.3 million, to Texas; and 3.0 million, to Colorado. Other States receiving smaller quantities included Illinois, Oklahoma, New Mexico, Wyoming, and Kansas.

² Utah Department of Natural Resources, Division of Oil, Gas, and Mining. Monthly Oil and Gas Production Report, December 1975.

Table 5.—Utah: Oil and gas well drilling completions in 1976, by county

County	Proved field wells ¹			Exploratory wells			Total	
	Oil	Gas	Dry	Oil	Gas	Dry	Wells	Footage
Carbon	--	1	--	--	--	--	1	2,330
Duchesne	30	--	1	--	--	--	31	348,408
Garfield	1	--	1	--	--	--	2	14,671
Grand	1	4	14	--	2	8	29	99,263
Millard	--	--	--	--	--	2	2	14,486
Salt Lake	--	--	--	--	--	2	2	10,120
San Juan	23	--	1	1	--	11	36	180,068
Sanpete	--	--	--	--	--	2	2	10,844
Sevier	--	--	--	--	--	2	2	5,873
Summit	3	--	--	--	--	2	5	63,138
Tooele	--	--	--	--	--	1	1	4,260
Uintah	2	--	--	1	1	3	7	76,524
Wayne	--	--	--	--	--	1	1	3,320
Total	60	5	17	2	3	34	121	833,305

¹ Development wells as defined by American Petroleum Institute.

Source: American Petroleum Institute.

According to API, 121 oil and gas wells were completed in the State during 1976. Fifty-four percent of the wells developed into producers—60 oil and 5 gas wells. Drilling activities were conducted in 13 counties. As in other years, a large number of the new productive wells were in Duchesne County. In 1976, 31 wells were drilled in Duchesne, with 30 becoming oil producers. In San Juan County, 36 wells were completed including 23 new oil producers.

METALS

Beryllium.—Brush Wellman, Inc., announced plans to expand its beryllium extraction facilities at Delta, Millard County. A beryl ore processing plant will be added at an estimated cost of \$4.5 million to treat ores currently processed in the company plant at Elmore, Ohio. The present

plant processes bertrandite ore from the company's mining operations at Spor Mountain, Juab County. When the addition is completed, the plant will be the only one in the United States capable of processing both bertrandite and beryl ores.

Copper.—The output of copper increased 5% over that of the previous year, largely because of more stabilized operations at Kennecott Copper Corp.'s Bingham Canyon mine. Total value of copper production increased 13% as a result of a slightly higher average price per pound compared with the 1975 price. The mine at Bingham was the largest single copper producer in the United States. Other significant copper producers in the State included Park City Ventures in the Park City area and the Burgin and Trixie mines in the East Tintic district. Copper production was recorded from seven mines in six counties.

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

County	Number of mines producing ¹ (lode)	Material sold or treated (short tons)	Gold		Silver		Total value
			Troy ounces	Value	Troy ounces	Value	
1974 total	8	35,824,728	254,909	\$40,719,164	3,207,923	\$15,109,317	
1975 total	6	27,751,500	189,620	30,621,734	2,821,730	12,472,048	
1976:							
Juab	1	5,583	363	45,491	54,492	237,041	
Salt Lake	1	29,609,704	W	W	W	W	
Uintah	1	15	--	--	--	--	
Utah	2	250,487	19,521	2,446,372	785,679	3,417,703	
Undistributed ²	3	187,445	167,434	20,982,829	2,293,850	9,978,247	
Total	8	30,053,234	187,318	23,474,692	3,134,021	13,632,991	
Copper							
Lead							
Zinc							
		Short tons	Value	Short tons	Value	Short tons	Value
1974 total		230,593	\$356,496,595	10,510	\$4,729,457	12,619	\$9,060,307
1975 total		177,155	227,467,442	12,679	5,452,099	19,640	15,319,143
1976:							
Juab	3	3,745	577	266,584	--	--	552,861
Salt Lake	185,085	257,637,788	--	--	--	--	W
Uintah	(³)	209	--	--	--	--	209
Utah	190	264,427	6,823	3,152,097	10,301	7,623,053	16,903,652
Undistributed ²	180	251,110	8,897	4,110,431	12,180	9,018,141	301,973,546
Total	185,458	258,157,279	16,297	7,529,112	22,481	16,636,194	319,430,268

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

¹ Operations at old mill or miscellaneous cleanups not counted as producing mines, nor are various uranium mines counted from which byproducts were recovered.

² Includes Iron, Millard, and Summit Counties combined to avoid disclosing individual company confidential data, and items indicated by symbol W.

³ Less than 1/2 unit.

Table 7.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by class of ore or other source material

Source	Number of mines ¹	Material sold or treated (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode ore:							
Gold-silver and silver ²	3	73,753	³ 185,769	³ 2,194,459	168	(⁴)	(⁴)
Copper	3	29,567,116	W	W	150,927	--	--
Lead	1	3,621	218	42,782	--	577	--
Lead-zinc	2	366,140	1,331	896,780	205	15,720	22,481
Total	6	29,936,877	1,549	939,562	151,132	16,297	22,481
Other lode material:							
Copper precipitates	1	42,604	--	--	34,157	--	--
Grand total	8	30,053,234	187,318	3,134,021	⁵ 185,458	16,297	22,481

W Withheld to avoid disclosing company proprietary data; included in "Gold-silver and silver."

¹ Detail will not add to total because some mines produce more than one class of material.

² Combined to avoid disclosing individual company confidential data.

³ Includes gold and silver from copper ore.

⁴ Less than 1/2 unit.

⁵ Data do not add to total shown because of independent rounding.

Table 8.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1976, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (short tons)	Lead (short tons)	Zinc (short tons)
Lode:					
Smelting of concentrates -----	167,772	2,667,767	151,132	16,297	22,481
Leaching -----	--	--	(¹)	--	--
Direct smelting of:					
Ore -----	19,546	466,254	168	--	--
Copper precipitates -----	--	--	34,157	--	--
Total -----	187,318	3,134,021	² 185,458	16,297	22,481

¹ Less than 1/2 unit.

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

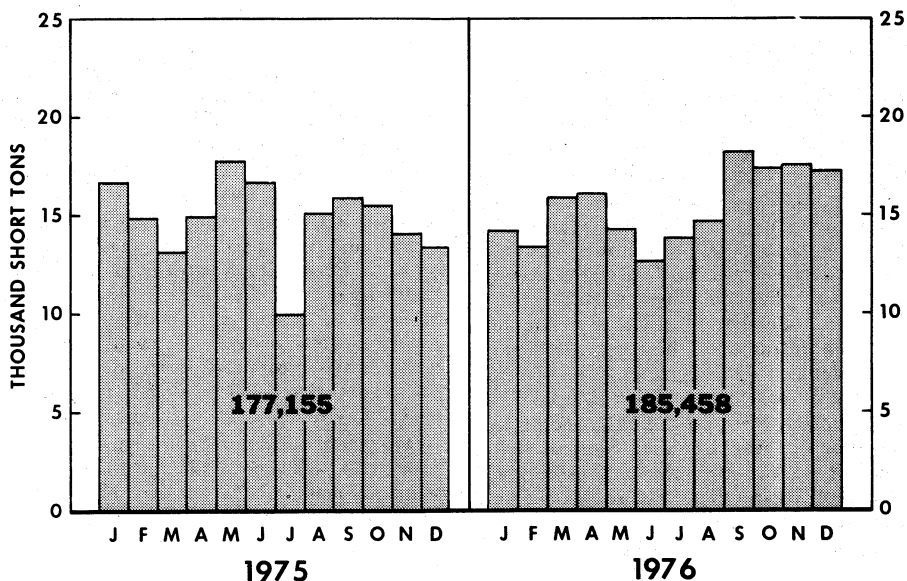


Figure 2.—Mine production of copper in Utah, by month, in terms of recoverable metals.

Gold.—Production of gold declined 1% in 1976, but the total value dropped 23% as a result of a lower average gold price through the year. Gold was produced at six mines in five counties. The principal producer was Kennecott Copper Corp. at the Bingham Canyon mine, followed by the Trixie mine in the East Tintic district, also operated by Kennecott. Kennecott's Tintic Division engaged in development work at the once-famous Mammoth gold mine near Eureka, Juab County. The mine, idle for 20 years, had produced gold, silver, copper, and lead. Dump material from the Mammoth mine is used as a fluxing agent in Kennecott's smelter near Magna.

Iron Ore.—All iron ores mined in the State were extracted from deposits in the Iron Mountain and Iron Springs areas of Iron County by two companies. CF&I Steel Corp. mined ore from the Comstock property on Iron Mountain and Utah International, Inc., produced low-grade ores from three properties in the Iron Springs area. A portion of Utah International's production was alluvial ore, which was upgraded in the company's portable plant. This ore, together with other crude ore, was concentrated in the magnetic separation plant at Iron Springs. The average content of iron for the direct shipping ores and concentrates was 54.43%. Total tonnage for the year decreased compared with that of 1975, but value increased. Virtually all production was used in the iron and steel industry.

Lead.—Ores containing lead were mined from four properties in Iron, Juab, Summit, and Utah Counties. The largest lead producers were the Ontario mine of Park City Ventures, United Park City Mines Co. in Summit County, and Kennecott's Burgin mine in Utah County. Lead production increased 29% over that of 1975. The average price per pound was greater and total value of production rose 38%.

Magnesium.—The Magnesium Div. of NL Industries, Inc., on the west shore of Great Salt Lake, suspended commercial production of magnesium metal at the end of April. The plant, designed for production of 45,000 tons of magnesium annually, has operated below capacity as a result of many technical problems. Plant

production was recessed to permit tests on a limited number of modified electrolytic cells. Representatives of the Norwegian magnesium producer Norsk Hydro A/S, Oslo, Norway, served as consultants for the project. As a result of the tests on the modified cells, plans were made for a \$30 million overhaul of the plant.

Molybdenum.—All molybdenum recovered in the State was a byproduct of concentration of copper sulfide ores from the Bingham district by Kennecott Copper Corp. Yield during the year decreased slightly more than 1% but greater average price for the commodity resulted in an 18% increase in value over that of 1975.

Selenium.—Production of selenium in 1976 increased 13%. As in past years, all production resulted from processing copper ore mined in the Bingham district by Kennecott Copper Corp.

Silver.—The leading silver producer in the State during 1976 was the Bingham mine of Kennecott Copper Corp. Other significant producers were the Ontario mine of Park City Ventures in the Park City area and the Burgin and Trixie mines in the East Tintic district operated by Kennecott. A total of seven mines in six counties produced silver during the year. Total silver yield was 11% more than in 1975. Value was 9% higher.

Tungsten.—Production of tungsten in Utah was 38% above that of 1975. Total value increased 71%, in part because of increased average price per unit of WO₃. Scheelite ores were produced from three mines in Box Elder County and two mines in Tooele County during 1976. The Box Elder County mines included the Blue Lady near Park Valley, operated by Condor Industries, Inc.; the Sun uranium property on the east side of the Newfoundland Range, mined by Sorenson and Collier; and the Glory Vein property, operated by Themco, Inc., and located 7 miles southeast of Yost. In Toole County, ore was mined on the Fraction Lode property by a lessee, Abracadabra Exploration Corp. This property was previously operated by Timm Tungsten Co. C&P Leasing also mined ores from the Star Dust property. The Tooele County mines lie 2 to 3 miles northwest of Gold Hill. Ores produced by Condor Industries, Inc., and C&P Leasing were sorted high-grade ores

and were sold without concentration. Ores from the other three mines were treated at custom mills in Nevada.

Uranium.—Uranium production came from mines in San Juan, Emery, and Grand Counties, with most of the production from San Juan County. Production of uranium in 1976 increased 20% in quantity and 57% in value. The average price rose from \$12.30 per pound U_3O_8 in 1975 to \$16.10 per pound in 1976.

Plans for construction of a plant to extract uranium from copper leaching solutions were announced by Wyoming Mineral Corp., a subsidiary of Western Westinghouse Electric Corp. The plant will be built adjacent to the copper leaching and precipitation facilities of Kennecott Copper Corp. in the Eingham district. Construction of the uranium plant will begin in early 1977, with completion planned near yearend 1977. Kennecott has operated a pilot uranium extraction plant in the Bingham area for the past several years. Wyoming Mineral Corp. expects to recover approximately 143,000 pounds of U_3O_8 annually from the uranium-bearing copper solutions.

Western Nuclear, Inc., a wholly owned subsidiary of Phelps Dodge Corp., conducted exploration and other investigations of the Marysvale uranium area, Piute County. Many claims in the central part of the district are held under lease by Western Nuclear. Several exploratory drill holes were completed and a low-angle inclined shaft was sunk to permit underground drilling and potential ore extraction. Considerable uranium ore, estimated at 275,000 tons, was mined in the area during the period 1949–67. The average grade was approximately 0.20% U_3O_8 . Western Nuclear also controls the Mystery Sniffer uranium property in the Indian Creek area of Beaver County, located 14 miles by road northeast of Beaver, and the Monarch and Eureka uranium-fluorspar property in the Wah Wah Range, 48 miles by road southwest of Milford, Beaver County.

Vanadium.—Production and value of vanadium increased notably during 1976. Nearly all vanadium-bearing ores were from mines in San Juan County, with a minor amount coming from Emery County. The ores were processed at mills in Utah and Colorado.

Zinc.—Two mines, the Ontario in Summit County and the Burgin in Utah County, produced virtually all the zinc mined in the State. Zinc tonnage increased 14% compared with that of 1975. Value of the zinc increased 9%.

NONMETALS

Barite.—Crude barite was not produced in the State in 1976. Barite from out-of-State mines was ground and prepared for well-drilling mud by the following five companies in Salt Lake County: All Minerals Corp., Custom Milling and Supply, Eisenman Chemical Co., Rocky Mountain Refractories, and Westemco, Inc.

Cement.—Output of portland cement increased 7% in quantity and 19% in value. Increases in quantity and value also were recorded for masonry cement. All production and sales were by Ideal Cement Co., Div. of Ideal Basic Industries, Inc., and Portland Cement Co. of Utah. Ready-mix concrete companies purchased 71% of the portland cement sold, highway contractors used 13%, concrete product manufacturers used 8%, building material dealers used 6%, and the remaining 2% was purchased by contractors and other users. Raw materials used in making portland cement included limestone, cement rock, gypsum, blast furnace slag, and sandstone.

Clays.—Production of clays fell 8% in quantity and 13% in value from output in 1975. Mining was conducted on 12 properties in 8 counties. Utelite Corp., Mountain Fuel Supply Co., Interpace Corp., and Filtrol Corporation accounted for almost 97% of the State's clay production. Materials listed as clays included common clay and shale, bentonite, fire clay, fuller's earth, and kaolin. Most of the clays were used as expanded material for concrete block and lightweight aggregate, in manufacturing building brick, and as catalysts in oil refining.

Fluorspar.—Production of fluorspar was substantially lower than in 1975. All production was classified as metallurgical-grade fluorspar. U.S. Energy Corp. in Juab County accounted for the total shipments.

Gypsum.—Five companies produced gypsum during the year from operations in Juab, Millard, Sanpete, and Sevier Counties. The producing companies were

Georgia-Pacific Corp., United States Gypsum Co., Cox Enterprises, Inc., Thomas J. Peck & Sons, Inc., and White Mountain Gypsum Co. Production of crude gypsum increased 9% in quantity and 14% in value. Georgia-Pacific Corp. and United States Gypsum Co. calcined gypsum mined in Sevier County. Output increased 8%.

Lime.—Four companies operating in three counties accounted for all the lime production in the State during 1976. The active companies were Utah Marblehead Lime Co. and The Flintkote Co., both in Tooele County; Kennecott Copper Corp. in Salt Lake County; and Utah-Idaho Sugar Co. in Box Elder County. The lime was used principally for refractories, mason's lime, and in the flotation of sulfide copper ores. Total lime output increased 25%. A total of 120,000 tons of lime was consumed in Utah. Other States using Utah lime were California, Idaho, and Colorado.

Magnesium Compounds.—Production of magnesium compounds, all from lake brines, was reported by Great Salt Lake Minerals & Chemical Corp., operating west of Ogden in Weber County, and Kaiser Aluminum & Chemical Corp. near Wendover, Tooele County. Production during 1976 increased 50% in quantity and 79% in value.

Perlite.—Plants of The Pax Co. in Salt Lake County and Georgia-Pacific Corp. in Sevier County expanded perlite from out-of-State sources. A substantial increase in expanded perlite for horticultural purposes and agricultural aggregate was reported. Another use was for plaster aggregate.

Phosphate Rock.—Stauffer Chemical Co. was the only producer of phosphate rock in the State. Two mines were active, an open pit property near Vernal in Uintah County and an underground mine in the Crawford Mountains, Rich County. Production declined 25%, but because of increased unit prices during the year, the total value was only 2% less.

Potash.—Three companies produced potash salts during the year. Texasgulf, Inc., used solution mining methods to recover salts from beds near Moab, Grand County. Kaiser Aluminum & Chemical Corp. extracted salts from brines at Wendover, Tooele County. The third company, Great Salt Lake Minerals & Chemicals Corp., produced salts from Great Salt

Lake waters west of Ogden in Weber County. Sales rose 19% in quantity and 5% in value over that reported in 1975.

Pumice.—Production of pumice and other volcanic materials increased nearly tenfold because of a new operation that produced material for landscaping and concrete aggregate. Other production was utilized in road construction. Filmore Products, Inc., mined material in Millard County and the Utah State Road Commission produced from a deposit in Iron County.

Salt.—Nine companies produced salt from plants in seven counties during 1976. Salt production increased 12% in quantity and 31% in value over that of 1975. Evaporated salt was produced by six companies operating in Box Elder, Salt Lake, Tooele, and Weber Counties. One mine each in Sanpete and Sevier Counties produced rock salt and an operation in Utah County produced brine. The salt was used in many industrial applications, including the chemical and animal-feed processing industries, but most was used for road salt.

Sand and Gravel.—Production of sand and gravel in Utah rose 4% during 1976, but because of a decrease in average unit price from \$1.41 per ton to \$1.27 per ton, the total value declined 6%.

In the nonmetallic group, sand and gravel remained in third place in total value of commodity production, after cement and potassium salts. A total of 85 mining operations were active in 25 of the 29 counties in the State. Salt Lake County was the leading producer, followed by Davis and Sanpete Counties. Operations in these three counties accounted for 62% of the State's sand and gravel production.

Sodium Sulfate.—Great Salt Lake Minerals & Chemicals Corp. produced sodium sulfate in its plant on the shore of Great Salt Lake, west of Ogden, Weber County. Production increased 47% in quantity and 57% in value.

Stone.—Production of stone was reported from 38 quarries in 15 counties during 1976. Total stone production increased 11% in quantity and 14% in value. Three counties—Box Elder, Morgan, and Utah—accounted for 67% of the total output. Principal producing companies were United States Steel Corp.; Ideal Cement Co., Div. of Ideal Basic Industries, Inc.; Southern Pacific Rail-

Table 9.—Utah: Crushed stone sold or used by producers, by use¹
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Cement -----	941	2,123	928	2,476
Riprap -----	583	875	W	W
Roadbase aggregate -----	3	6	26	51
Rockdust for coal mines -----	18	154	W	W
Roadstone -----	3	5	10	21
Terrazzo -----	10	296	W	W
Fill -----	3	3	--	--
Other uses ² -----	922	2,455	1,780	4,133
Total ³ -----	2,482	5,916	2,744	6,681

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

¹ Includes limestone, miscellaneous stone, sandstone, marble (1975), and granite (1976).

² Includes ferrosilicon, lime (including dead-burned dolomite), surface treatment aggregate, agricultural limestone, flux stone, refractory stone, railroad ballast, stone sand, mineral food, other uses, and uses indicated by symbol W.

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

road Co.; and Portland Cement Co. of Utah.

Vermiculite.—Crude vermiculite was not produced in Utah in 1976, but out-of-State material was exfoliated by Vermiculite Intermountain, Inc., Salt Lake

City. The product was sold and used principally as loose fill insulation. Other uses included roofing aggregate, concrete aggregate, plaster aggregate, soil conditioning, and pipe covering.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt: American Gilsonite Co.	Suite 1150, Kennecott Bldg. Salt Lake City, Utah 84110	Underground mine and plant.	Uintah.
Beryllium: Brush Wellman, Inc	67 W. 2950 S. Salt Lake City, Utah 84115	Open pit mines and plant.	Juab and Millard.
Carbon dioxide, natural: Equity Oil Co.	806 American Oil Bldg. Salt Lake City, Utah 84101	Well and plant	Carbon.
Cement:			
Ideal Basic Industries, Inc. ¹	420 Ideal Cement Bldg. Denver, Colo. 80202	Plant	Morgan.
Portland Cement Co. of Utah. ¹	Box 1469 Salt Lake City, Utah 84110	-----do -----	Salt Lake.
Clays:			
Filtrol Corp -----	3250 E. Washington Blvd. Los Angeles, Calif. 90023	Open pit and underground mines.	Juab.
Interpace Corp -----	2901 Los Feliz Blvd. Los Angeles, Calif. 90030	Open pit mine	Sevier, Utah, Weber.
Utelite Corp -----	RFD Coalville, Utah 84017	Open pit mine and plant.	Summit.
Coal:			
American Coal Co -----	190 N. Main Huntington, Utah 84528	Underground mine.	Emery.
Kaiser Steel Corp -----	Sunnyside Coal Mines Sunnyside, Utah 84539	Underground mines and plant.	Carbon.
Peabody Coal Co -----	301 N. Memorial Dr. St. Louis, Mo. 36102	Underground mine.	Emery.
Copper: Kennecott Copper Corp. ²	Box 11299 Salt Lake City, Utah 84111	Open pit mine, mills, smelter, refinery.	Salt Lake and Utah.
Fluorspar: U.S. Energy Corp --	625 East Madison, Suite 1 Riverton, Wyo. 82501	Open pit mine	Juab.
Gypsum:			
Georgia-Pacific Corp -----	Box 311 Portland, Oreg. 97204	Open pit mine and plant.	Sevier.
United States Gypsum Co --	101 S. Wacker Dr. Chicago, Ill. 60606	-----do -----	Do.

See footnotes at end of table.

Table 10.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
CF&I Steel Corp -----	Box 1920 Pueblo, Colo. 80201	Open pit mines ---	Iron.
Utah International, Inc ---	Box 649 Cedar City, Utah 84720	Open pit mines and plants.	Do.
Lead: United Park City Mines Co. ³	Box 1450 Park City, Utah 84060	Underground mine and plant.	Summit.
Lime:			
The Flinkote Co. ¹ -----	2244 Beverly Blvd. Los Angeles, Calif. 90057	Plant -----	Tooele.
Utah-Marblehead Lime Co -	300 W. Washington St. Chicago, Ill. 60606	---do -----	Do.
Petroleum and natural gas:⁴			
Potassium salts:			
Great Salt Lake Minerals & Chemicals Corp. ⁵	Box 1190 Ogden, Utah 84402	---do -----	Weber.
Kaiser Aluminum & Chemical Corp. ⁶	800 Lakeside Dr. Oakland, Calif. 94604	---do -----	Tooele.
Texasgulf, Inc -----	200 Park Ave. New York, N.Y. 10017	Underground mine and refinery.	Grand.
Salt:			
American Salt Co -----	3142 Broadway Kansas City, Mo. 64111	Plant -----	Tooele.
Morton International Inc --	110 N. Wacker Dr. Chicago, Ill. 60606	---do -----	Salt Lake.
Sand and gravel:			
Cox Construction Co., Inc -	270 North First E. Manti, Utah 84642	---do -----	Sanpete.
Gibbons & Reed Co -----	41 W. Central Ave. Murray, Utah 84107	Pits and plants ---	Davis, Salt Lake, Weber. Salt Lake.
Monroc Sand and Gravel --	Box 537 Salt Lake City, Utah 84116	---do -----	Salt Lake.
Parson Red-E-Mix & Paving Co.	Box 517 Brigham City, Utah 84302	---do -----	Box Elder.
Stone:			
Southern Pacific Railroad Co.	65 Market St. San Francisco, Calif. 94105	Quarry -----	Do.
Utah Calcium Co., Inc ----	989 Jewel Ave. Salt Lake City, Utah 84115	---do -----	Tooele.
United States Steel Corp., Western Stone Operations.	Box 569 Lander, Wyo. 82520	Quarry and plant -	Utah.
Uranium:			
Atlas Minerals Division of Atlas Corp. ⁷	Box 488 Moab, Utah 84532	Underground mines and plant.	Emery, Grand, San Juan.
Rio Algom Corp. ⁷ -----	Box 610 Moab, Utah 84532	Underground mine--	San Juan.
Union Carbide Corp -----	270 Park Ave. New York, N.Y. 10017	---do -----	Grand.

¹ Also stone.² Also gold, silver, lead, zinc, molybdenum, selenium, lime, and stone.³ Also zinc, copper, gold, and silver.⁴ Many of the major oil companies and some of the smaller companies operate in Utah; the companies are listed in several commercial directories.⁵ Also salt and magnesium compounds.⁶ Also magnesium compounds.⁷ Also vanadium.

The Mineral Industry of Vermont

This chapter has been prepared under a cooperative agreement 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 minerals except fuels.

By William R. Barton¹ and Charles A. Ratte²

The value of minerals produced in Vermont during 1976 was 22% higher than in 1975. The higher value reflected increased production of almost all mineral commodities. The major commodities produced in the State in decreasing order of value were: Stone, asbestos, sand and gravel, and talc.

The Vermont mineral industry is significant nationally as a producer of dimension granite, dimension marble, dimension slate, asbestos, talc, and ground marble. Some of the Vermont dimension stones are exported and recognized worldwide. The Vermont mineral industry is of critical importance to Vermont railroads—the Vermont Northern Railroad normally generates about one-half of its revenue

from mineral products; 20% of the total traffic over Vermont Railway is in Vermont minerals; the Green Mountain Railroad depends upon minerals for about 75% of its traffic; and the Montpelier and Barre Railroad is dependent upon shipments of granite for profitable operation.

About 40,000 pounds of new mineral materials is required annually, including mineral fuels, to support each U.S. citizen; in Vermont about 17,000 pounds per capita is produced. The deficiency is mostly due to nonexistent production of metals and mineral fuels in Vermont at present. Vermont more than fulfills its per

¹ State Liaison Officer, Bureau of Mines, Newmarket, N.H.

² State geologist, Montpelier, Vt.

Table 1.—Mineral production in Vermont¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Peat -----short tons-----	(²)	W	--	--
Sand and gravel -----thousand short tons-----	2,356	\$3,693	³ 2,379	³ \$3,758
Stone -----do-----	1,224	15,718	1,978	22,443
Talc -----short tons-----	230,973	1,918	252,371	1,685
Value of items that cannot be disclosed:				
Asbestos, gem stones, sand and gravel (industrial, 1976), and values indicated by symbol W -----	XX	7,450	XX	7,211
Total -----	XX	28,779	XX	35,097
Total 1967 constant dollars -----	XX	11,388	XX	⁴ 12,617

² Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." 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 Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Vermont, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Addison -----	W	\$3,167	Stone, sand and gravel.
Bennington -----	\$305	310	Sand and gravel, stone.
Caledonia -----	W	1,822	Stone, sand and gravel.
Chittenden -----	1,562	1,646	Do.
Essex -----	W	W	Sand and gravel, stone.
Franklin -----	W	W	Stone, sand and gravel.
Grand Isle -----	1	W	Stone.
Lamoille -----	W	W	Talc, sand and gravel, stone.
Orange -----	W	W	Stone, sand and gravel.
Orleans -----	W	W	Asbestos, sand and gravel, stone.
Rutland -----	5,299	8,983	Stone, sand and gravel.
Washington -----	5,293	7,110	Do.
Windham -----	475	W	Talc, sand and gravel, stone.
Windsor -----	W	W	Talc, stone, sand and gravel.
Undistributed ¹ -----	15,842	12,061	
Total ² -----	28,779	35,097	

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

	1975	1976 ^P	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands..	201.7	216.0	+7.1
Unemployment -----do-----	19.4	19.0	-2.1
Employment (nonagricultural):			
Mining -----do-----	.8	.7	-12.5
Manufacturing -----do-----	39.5	41.1	+4.1
Contract construction -----do-----	7.4	7.7	+4.1
Transportation and public utilities -----do-----	8.2	8.3	+1.2
Wholesale and retail trade -----do-----	33.7	34.8	+3.3
Finance, insurance, real estate -----do-----	6.6	6.7	+1.5
Services -----do-----	35.5	38.3	+7.9
Government -----do-----	30.5	30.8	+1.0
Total nonagricultural employment -----do-----	¹ 162.1	¹ 168.2	+3.8
Personal income:			
Total -----millions..	\$2,313	\$2,577	+11.4
Per capita -----do-----	\$4,900	\$5,411	+10.4
Construction activity:			
Number of private and public residential units authorized ..	1,768	2,201	+24.5
Value of nonresidential construction -----millions..	\$12.6	\$14.4	+14.3
Value of State road contract awards -----do-----	\$31.4	\$30.0	-4.5
Shipments of portland and masonry cement to and within the State -----thousand short tons..	114	114	--
Mineral production value:			
Total crude mineral value -----millions..	\$28.8	\$35.1	+22.0
Value per capita, resident population -----do-----	\$61	\$74	+21.3
Value per square mile -----do-----	\$2,995	\$3,653	+22.0

^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.

Table 4.—Worktime and injury experience in the Vermont mineral industry in 1976¹

	Men	Manhours	Fatal injuries	Fatal frequency rate	Non-fatal disabling injuries	Non-fatal disabling frequency rate	Nondisabling injuries	Nondisabling frequency rate
Sand and gravel:								
Surface	186	162,208	--	--	5	30.82	1	6.16
Office	41	41,949	--	--	--	--	--	--
Total	227	204,157	--	--	5	24.49	1	4.90
Stone:								
Underground	44	79,959	--	--	4	50.08	--	--
Surface	414	678,411	1	1.47	17	25.06	4	5.90
Mills	282	541,098	--	--	7	12.94	--	--
Office	101	183,943	--	--	--	--	--	--
Total	841	1,483,411	1	.67	28	18.88	4	2.70
Talc:								
Underground	57	128,532	1	7.78	10	77.80	6	46.68
Surface	4	6,720	--	--	1	148.81	--	--
Mills	84	191,683	--	--	12	62.60	10	52.17
Office	20	35,973	--	--	--	--	--	--
Total	165	362,908	1	2.76	23	63.38	16	44.09
Asbestos:								
Surface	48	105,131	--	--	2	19.02	--	--
Mills	113	246,745	--	--	3	12.16	--	--
Office	21	38,213	--	--	--	--	--	--
Total	182	390,089	--	--	5	12.82	--	--
State totals:								
Underground	101	208,491	1	4.80	14	67.15	6	28.78
Surface	652	952,470	1	1.05	25	26.25	5	5.25
Mills	479	979,526	--	--	22	22.46	10	10.21
Office	183	300,078	--	--	--	--	--	--
Grand total	1,415	2,440,565	2	.82	61	24.99	21	8.60

¹ Data supplied by Mining Safety and Health Administration, U.S. Department of Labor.

capita share of production of nonmetallic minerals (U.S. average consumption is 11,740 pounds of nonmetallics per capita), and is a net exporter of nonmetallic mineral products. The value of Vermont mineral products is equal to about 5% of the entire value added by all manufacturing establishments in the State. In addition, stone, clay, and glass products manufactures and primary metal industries represent about 10% of the total State manufacturing economy and employ somewhat more than 10% of manufacturing employees. Locally, impact may be even greater. For example, in Barre, 57 out of 73 manufacturing establishments turned out stone, clay, or glass products—primarily granite monuments. In Rutland County, one-fifth of the manufacturing establishments are engaged in the same business category (mostly marble finishing).

Vermont is almost totally dependent upon imported mineral-derived fuels for energy. Only 7% of requirements are met

from hydropower. The rest is derived as follows: 58% petroleum products (gasoline, distillates, residual, etc.), 32% nuclear, 2% natural gas, and 1% coal.

A visitor guide to mining and mineral operations in the northeast, including Vermont, was published by the Bureau of Mines.³ The booklet described active and abandoned mining sites and camps that can be visited or easily viewed from major highways.

Legislation and Government Programs.—The position of the Vermont State Geologist was moved from the University of Vermont at Burlington to the Planning Division of the Agency of Environmental Conservation at Montpelier effective July 1, 1976. Dr. Charles G. Doll became State Geologist Emeritus and Dr. Charles Ratté became the new State Geologist.

³ U.S. Bureau of Mines. Mining and Mineral Operations in the New England and Mid-Atlantic States. A Visitor Guide. BuMines SP 10-76, 1976, pp. 65-72.

Public Law 94-268 redefined the limits of the Bristol Cliffs Wilderness Area. The revision of the boundaries excluded certain

private lands that had been previously included in the wilderness area.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Asbestos.—Vermont Asbestos Group, Inc. (VAG), completed its first year of operations and declared a 100% dividend. The firm said it had already installed most of the pollution control equipment required by the Environmental Protection Agency (EPA), cleared its debts, and had found sufficient new ore to support continued operations for many years. The firm also announced tentative plans to construct a board plant in Morrisville to use asbestos mill tailings as plant feed.

Cement.—Vermont has no cement producing plants and imports all of the commodity it needs. Preliminary Bureau of Mines data indicated that 108,582 tons of portland cement and 5,205 tons of prepared masonry cement were shipped to Vermont destinations in 1976. These compared with 108,620 tons and 5,100 tons shipped in 1975.

Gem Stones.—The value of gem stones and mineral specimens collected was estimated at several thousand dollars.

Mica, Reconstituted.—At Rutland, U.S. Samica Corp. processed delaminated scrap mica in the manufacture of reconstituted sheet mica for use in electrical insulation.

Sand and Gravel.—Construction sand and gravel production increased 1% in quantity and almost 2% in value. Average value per ton was \$1.58 (\$1.57 in 1975). Production from 49 operations totaled 2.4 million tons of construction sand and gravel with a value of \$3.8 million. Leading counties were Chittenden, Rutland, Franklin, Bennington, Orleans, and Addison. Leading commercial producers were Hinesburg Sand and Gravel Co.; M & T Sand and Gravel Co.; Calkins Construction, Inc.; J. P. Carrara & Sons, Inc.; and S. T. Griswold, Inc.

The Vermont Department of Highways purchased sand and gravel from commercial producers and contracted for production as part of construction and maintenance projects. Its own crews produced sand for ice control and gravel for routine paving and maintenance.

Table 5.—Vermont: Construction sand and gravel sold or used by producers

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand	1,332	\$1,579	\$1.19
Gravel	1,049	2,181	2.08
Total ¹	2,379	3,758	1.58

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

Table 6.—Vermont: Construction sand and gravel sold or used by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	823	\$1,553	\$1.89
Concrete products (cement blocks, bricks, pipe, etc.) -----	159	330	2.08
Asphaltic (concrete aggregates and other bituminous mixtures) -----	372	817	2.20
Roadbase and coverings -----	497	524	1.05
Fill -----	322	280	.87
Other uses -----	208	256	1.23
Total ¹ -----	2,379	3,758	1.58

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

Stone.—Eighteen companies quarried dimension stone at 27 quarries for rough monumental stone, rough blocks, dressed flagging, and other uses. Output increased 1% to 121,240 tons valued at \$11.5 million. Leading companies were Rock of Ages Corp. and Vermont Marble Co. Ten companies crushed stone at 37 quarries for roadstone, riprap, surface treatment aggregate, and other uses. Output expanded 68% to 1.9 million tons valued at \$11 million. Leading producers were the Vermont Highway Department, Shelburne Limestone Corp., and Frank W. Whitcomb Construction Corp.

Among the States, Vermont led in production of dimension marble, ranked second in output of dimension granite and dimension slate, and was third in output of total dimension stone.

Pleuss-Stauffer North American, Inc., a subsidiary of Pleuss-Stauffer of Oftringen, Switzerland, purchased a majority interest in Vermont Marble Co., its subsidiaries, and land holdings. The Vermont firm was in the midst of a \$2.7 million streamlining and modernization program financed with federally guaranteed loans under a program to assist firms adversely impacted by imports under relaxed tariff schedules. The Swiss firm had intended to open its own mine and plant in Danby, but now will

not need to follow that course. The streamlining of the Vermont Marble operation included closing the West Rutland mill by transferring operations to Proctor and Danby. Primary sawing by diamond gang saws was transferred to an underground installation at Danby.

Vermont Marble Co. operated three dimension stone quarries during the year: Danby (white), Isle La Motte (black), and Roxbury (verde antique). Ground marble (including limestone) production increased substantially. The product was used principally for filler in items such as plastics, synthetic rubber, and chewing gum. As prices of plastic feedstocks increased, fabricators were tending to increase percentages of filler in their products.

Rock of Ages Corp. operated five quarries (in gray granite) and a finishing plant at Barre, and a sixth quarry (in white granite) at Bethel. Dimension granite shipments were restrained in 1976 because of effects from the general economic recession.

Expansion of crushed slate for lightweight aggregate at Castleton ceased during 1975, and in 1976 portions of the Vermont Light Aggregate Corp. plant were being dismantled and moved from the site.

Table 7.—Vermont: Production of dimension stone, by use

Use	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Rough monumental -----	75,890	\$6,558	79,660	\$7,043
Rough blocks -----	21,310	2,258	18,640	1,951
Dressed flagging -----	11,860	402	12,060	404
Flooring -----	4,407	614	3,835	564
Roofing slate -----	1,272	239	1,553	386
Other uses ¹ -----	5,470	814	5,493	1,133
Total ² -----	120,214	10,935	121,240	11,481

¹ Includes stone used in dressed monumental, structural and sanitary purposes, house stone veneer, and other uses (1975).

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

Table 8.—Vermont: Production of crushed stone,¹ by use

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Roadstone -----	220	395	631	1,604
Riprap and jetty stone -----	111	162	300	546
Surface treatment aggregate -----	164	354	226	530
Bituminous aggregate -----	60	140	115	261
Concrete aggregate -----	107	238	79	196
Railroad ballast -----	W	W	74	172
Dense-graded roadbase stone -----	58	97	72	146
Agricultural limestone -----	126	505	W	W
Other uses ² -----	259	2,893	360	7,506
Total ³ -----	1,104	4,783	1,857	10,960

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

¹ Includes limestone, miscellaneous stone, traprock, sandstone, granite, and marble.

² Includes whitening, other filler, terrazzo and exposed aggregate, paper manufacture, mineral food, roofing granules, other uses, and uses indicated by symbol W.

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

Talc.—Three companies mined and ground talc in 1976. Production increased over that of 1975. The ground talc was sold and used for toilet preparations, plastics, rubber, paper, paint, insecticides, asphalt filler, refractories, foundry facings, and export. Vermont Soapstone Co., Inc., fabricated soapstone stoves, griddles, and other products at its Perkinsville plant. The National Institute of Occupational Safety and Health (NIOSH) reported that studies indicated there may be excess mortality from lung diseases at Vermont talc mills. The histories of 405 talc workers were investigated and 17 had died of lung-related diseases. The incidence was said to be well above the national average by NIOSH.

MINERAL FUELS

Statistics on Vermont fuel consumption are published annually in the New England Fuel Institute (NEFI) Statistical Fact

Book. The book appears as the March issue of "Yankee Oilman" magazine published by NEFI. Data for 1974 were published in March 1976.

The Bureau of Mines published two reports detailing fuels and energy data by individual Eastern States including Vermont.⁴ Another Bureau of Mines Information Circular shows the results of a June 1976 survey of planned or proposed coal mines, coal and noncoal conversion plants, oil refineries, uranium enrichment facilities, and related infrastructures.⁵

⁴ Crump, L. H. Historical Fuels and Energy Consumption Data, 1960-72, United States by States and Census Districts East of the Mississippi. BuMines IC 8704, 1976, 456 pp.

⁵ Fuels and Energy Data: United States by States and Census Divisions, 1973. BuMines IC 8722, 1976, 112 pp.

⁶ U.S. Bureau of Mines. Projects to Expand Fuel Sources in Eastern States. Survey of Planned or Proposed Coal Mines, Coal and Noncoal Conversion Plants, Electric Generating Plants, Oil Refineries, Uranium Enrichment Facilities, and Related Infrastructure, in States East of the Mississippi River (as of June 1976). BuMines IC 8725, 1976, 114 pp.

Petroleum and Natural Gas.—Natural gas has been known to exist in the Champlain Valley of Vermont for many years. It is present in some water wells and it has been encountered in drilling for water. Some gas-producing wells are located just to the north in Canada.

The Energy Research and Development Administration (ERDA) laboratory at Bartlesville, Okla., detected soil gas anomalies from northwestern Vermont samples that suggested petroleum or gas concentrations at depth. However, ERDA denied a request for \$2 million to test drill a 12,000-foot hole to determine the gas potential of northwestern Vermont. The Vermont Energy Director said ERDA reported

that the exploration effort would be beyond the scope of their activities.

Uranium.—Several firms were actively exploring for uranium in 1976.

ERDA conducted airborne geophysical surveys that confirmed earlier reports of uranium-phosphate bearing zones in the Clarendon Springs Formation. The anomalies proved to be small in surface expression. ERDA sponsored limited hydrogeochemical sampling in the vicinity of the Udall mine near Wolcott.

METALS

Prospecting for copper and other base metals continued during 1976.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos: Vermont Asbestos Group, Inc. ¹	Box 70 Hyde Park, Vt. 05655	Pit -----	Orleans.
Sand and gravel:			
Calkins Construction, Inc.	Lyndonville, Vt. 05851	Pit -----	Caledonia and Orleans.
J. P. Carrara & Sons, Inc.	Rutland, Vt. 05701	Pit -----	Addison and Rutland.
S. T. Griswold, Inc.	Williston, Vt. 05495	Pit -----	Chittenden.
Hinesburg Sand and Gravel Co.	Hinesburg, Vt. 05461	Pit -----	Do.
M & T Sand & Gravel Co.	Swanton, Vt. 05488	Pit -----	Franklin.
Stone:			
Granite (dimension):			
Rock of Ages Corp	Barre, Vt. 05641	Quarries -----	Orange, Washington, Windsor.
Wells-Lamson Quarry Co., Inc. ²	---do -----	Quarry -----	Washington.
Limestone, dolomite, and marble (crushed, ground, and broken):			
Shelburne Limestone Corp.	30 Jewett St. Shelburne, Vt. 05482	---do -----	Chittenden and Franklin.
Vermarco	Proctor, Vt. 05765	Quarries -----	Rutland.
White Pigment Corp	---do -----	---do -----	Addison and Rutland.
Marble (dimension):			
Vermont Marble Co. ³	---do -----	---do -----	Grand Isle, Rutland, Windsor.
Slate (dimension):			
John G. Hadeka	Poultney, Vt. 05764	---do -----	Rutland.
Hilltop Slate Co	Middle Granville, N.Y. 12849	---do -----	Do.
Taran Bros., Inc	North Poultney, Vt. 05764	---do -----	Do.
Tatko Bros. Slate Co	---do -----	---do -----	Do.
Vermont Structural Slate Co., Inc.	Fair Haven, Vt. 05743	---do -----	Do.
Talc:			
Eastern Magnesia Talc Co	Johnston, Vt. 05656	Underground mines	Lamoille.
Vermont Talc, Inc	Chester, Vt. 05143	---do -----	Windham.
Windsor Minerals, Inc	Windsor, Vt. 05089	---do -----	Windsor.

¹ Also miscellaneous stone.

² Also crushed and broken granite.

³ Also crushed and broken limestone and dolomite.

The Mineral Industry of Virginia

This chapter has been prepared in part under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the Virginia Division of Mineral Resources which is limited to the collection of information on all minerals except fuels.

By Lawrence E. Shirley ¹ and D. C. LeVan ²

The total value of mineral production in 1976 was \$1,160.6 million, a decrease of 8% from that of 1975. The decline in mineral production value, the first in many years, was due primarily to a decrease in the value of bituminous coal, the State's leading mineral commodity.

Virginia led the Nation in production of kyanite and crushed slate and was the only State that produced aplite.

Bituminous coal, stone, cement (masonry and portland), lime, and sand and gravel, listed in descending order of value, were the principal mineral commodities produced

during the year, accounting for more than 95% of the total mineral production value of the State.

Production of fuels other than coal consisted of natural gas and a small amount of crude petroleum.

In metals, zinc and lead output continued a downward trend. A small amount of silver was recovered from the smelting of the zinc and lead.

¹ State Liaison Officer, Bureau of Mines, Raleigh, N.C.

² Geologist, Virginia Division of Mineral Resources, Charlottesville, Va.

Table 1.—Mineral production in Virginia ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays -----thousand short tons--	819	\$1,152	862	\$1,210
Coal (bituminous) -----do-----	35,510	1,081,587	39,996	964,669
Gem stones -----	NA	13	NA	12
Lead (recoverable content of ores, etc.)				
-----short tons--	2,551	1,097	1,946	899
Lime -----thousand short tons--	705	20,192	878	25,993
Natural gas -----million cubic feet--	6,723	3,462	6,937	7,908
Petroleum (crude) -----thousand 42-gallon barrels--	3	W	3	W
Sand and gravel -----thousand short tons--	9,895	24,776	² 10,191	² 23,089
Stone -----do-----	35,384	84,204	36,132	91,723
Zinc (recoverable content of ores, etc.)				
-----short tons--	15,151	11,818	11,241	8,319
Value of items that cannot be disclosed:				
Aplite, cement, gypsum, kyanite, sand and gravel (industrial, 1976), silver, talc (soapstone), and values indicated by symbol W -----	XX	33,673	XX	36,823
Total -----	XX	1,261,974	XX	1,160,645
Total 1967 constant dollars -----	XX	499,363	XX	P 417,252

¹ Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

² Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

³ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Virginia, by county¹
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Accomack	\$121	\$146	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Alleghany	--	180	Stone.
Amherst	W	W	Stone, sand and gravel.
Appomattox	W	327	Stone.
Augusta	W	W	Stone, sand and gravel.
Bedford	W	W	Stone.
Bland	778	96	Do.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buchanan	452,912	W	Coal, natural gas.
Buckingham	W	W	Kyanite, stone.
Campbell	2,341	2,238	Stone, sand and gravel.
Caroline	705	638	Sand and gravel.
Charles City	W	W	Do.
Charlottesville (city)	1	17	Do.
Chesapeake (city)	W	W	Cement, sand and gravel.
Chesterfield	W	6,044	Sand and gravel, stone.
Clarke	W	W	Stone.
Craig	162	462	Sand and gravel.
Culpeper	W	W	Stone.
Dickenson	182,739	W	Coal, natural gas.
Dinwiddie	W	W	Stone.
Fairfax	W	W	Stone, sand and gravel.
Fauquier	W	W	Stone.
Floyd	23	20	Do.
Franklin	W	W	Stone, soapstone.
Frederick	W	W	Stone, lime, sand and gravel, gypsum.
Giles	W	W	Lime, stone.
Gloucester	32	38	Sand and gravel.
Goochland	3,882	3,100	Stone.
Grayson	W	439	Stone, sand and gravel.
Greene	W	W	Do.
Greensville	W	W	Stone, clays.
Halifax	W	W	Stone, sand and gravel.
Hanover	W	W	Stone, sand and gravel, aplite.
Henrico	6,009	9,145	Sand and gravel, stone.
Henry	W	W	Stone.
Highland	128	97	Do.
Isle of Wight	W	W	Lime, sand and gravel.
James City	15	W	Sand and gravel.
King and Queen	W	W	Do.
King George	W	W	Sand and gravel.
King William	W	W	Do.
Lancaster	W	W	Do.
Lee	31,261	W	Coal, stone, petroleum.
Loudoun	5,145	6,259	Stone.
Middlesex	2	5	Sand and gravel.
Montgomery	W	817	Stone, clays.
Nelson	W	W	Aplite, stone.
New Kent	W	W	Sand and gravel.
Newport News (city)	W	W	Do.
Northampton	18	12	Do.
Northumberland	W	W	Do.
Nottoway	W	W	Stone.
Orange	W	W	Clays.
Page	W	W	Stone.
Patrick	W	--	Do.
Pittsylvania	W	W	Stone, sand and gravel.
Portsmouth (city)	52	--	Do.
Powhatan	W	W	Stone.
Prince Edward	W	W	Kyanite, stone.
Prince George	W	W	Sand and gravel.
Prince William	W	W	Stone, clays.
Pulaski	W	W	Stone.
Rappahannock	W	W	Do.
Richmond (city)	W	W	Stone, clays.
Roanoke	2,692	2,819	Do.
Rockbridge	W	W	Do.
Rockingham	W	W	Stone, sand and gravel.
Russell	74,853	4,411	Stone, coal.
Scott	1,550	1,806	Stone.
Shenandoah	W	W	Lime, stone.
Smyth	W	W	Stone, clays, sand and gravel, gypsum.
Southampton	--	W	Sand and gravel.
Spotsylvania	805	W	Stone, sand and gravel.
Stafford	W	W	Sand and gravel.

See footnotes at end of table.

Table 2.—Value of mineral production in Virginia, by county¹—Continued
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Suffolk (city) -----	\$1	W	Sand and gravel.
Surry -----	W	W	Do.
Sussex -----	W	W	
Tazewell -----	W	W	Coal, stone, natural gas, clays.
Virginia Beach (city) ----	1,186	\$1,219	Sand and gravel.
Warren -----	W	W	Cement, stone, sand and gravel.
Washington -----	W	W	Stone, gypsum.
Westmoreland -----	70	67	Sand and gravel.
Wise -----	W	W	Coal, stone, natural gas.
Wythe -----	W	W	Zinc, stone, lead, silver.
York -----	95	88	Sand and gravel.
Undistributed ² -----	494,393	1,120,193	
Total ³ -----	1,261,974	1,160,645	

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

¹ The following counties or cities are not listed because no production was reported: Alexandria (city), Amelia, Arlington, Bath, Bedford (city), Bristol (city), Buena Vista (city), Carroll, Charlotte, Clifton Forge (city), Colonial Heights (city), Covington (city), Cumberland, Danville (city), Emporia (city), Essex, Fairfax (city), Falls Church (city), Fluvanna, Franklin (city), Fredericksburg (city), Galax (city), Hampton (city), Harrisonburg (city), Hopewell (city), Lexington (city), Louisa, Lunenburg, Lynchburg (city), Madison, Martinsville (city), Mathews, Mecklenburg, Nansemond, Norfolk (city), Norton (city), Petersburg (city), Radford (city), Richmond, Roanoke (city), Salem (city), South Boston (city), Staunton (city), Waynesboro (city), Williamsburg (city), and Winchester (city).

² Includes gem stones, coal, 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

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	2,247.0	2,306.0	+2.6
Unemployment -----do-----	144.0	136.0	-5.6
Employment (nonagricultural):			
Mining -----do-----	20.9	21.8	+4.3
Manufacturing -----do-----	371.5	387.1	+4.2
Contract construction -----do-----	112.0	112.4	+4
Transportation and public utilities -----do-----	103.8	106.2	+2.3
Wholesale and retail trade -----do-----	368.0	383.8	+4.3
Finance, insurance, real estate -----do-----	84.0	86.0	+2.4
Services -----do-----	296.9	312.5	+5.3
Government -----do-----	421.6	432.9	+2.7
Total nonagricultural employment -----do-----	1,778.7	1,842.7	+3.6
Personal income:			
Total -----millions--	\$28,774	\$31,908	+10.9
Per capita -----do-----	\$5,777	\$6,341	+9.8
Construction activity:			
Number of private and public residential units authorized -----do-----	33,210	39,862	+20.0
Value of nonresidential construction -----millions--	\$440.9	\$473.5	+7.4
Value of State road contract awards -----do-----	\$257.0	\$294.0	+14.4
Shipments of portland and masonry cement to and within the State -----thousand short tons--	1,756	1,781	+1.4
Mineral production value:			
Total crude mineral value -----millions--	\$1,262.0	\$1,160.6	-8.0
Value per capita, resident population -----do-----	\$253	\$231	-8.7
Value per square mile -----do-----	\$30,918	\$28,435	-8.0

^p Preliminary.

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

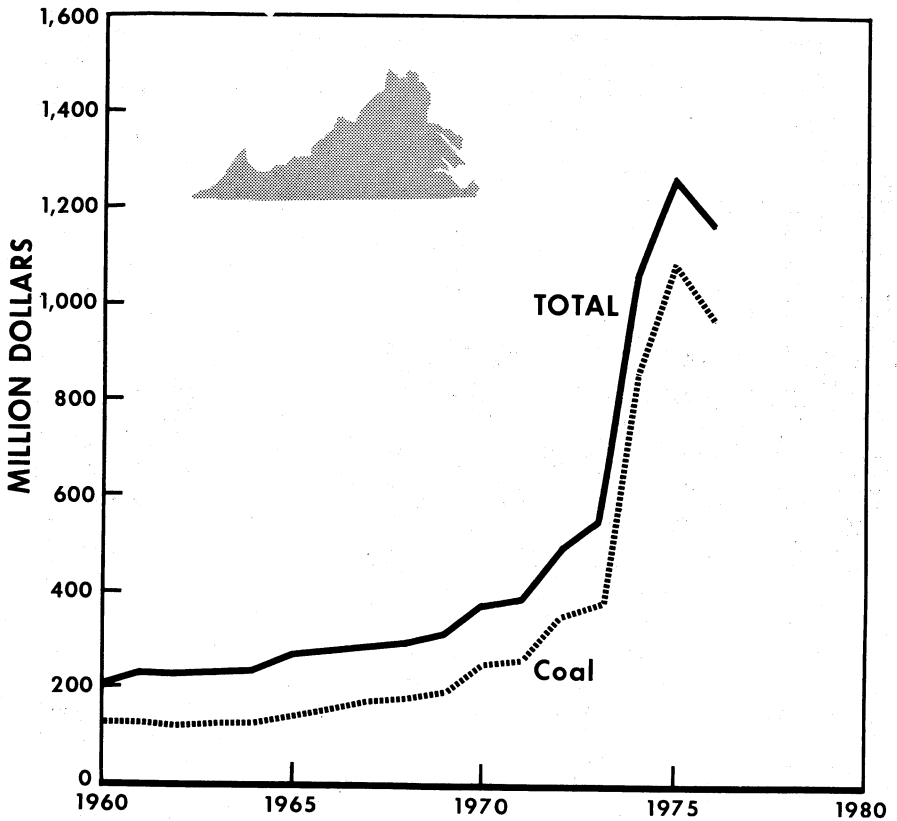


Figure 1.—Value of coal and total value of all mineral production in Virginia.

Legislation and Government Programs.—The Division of Mineral Resources, Virginia Department of Conservation and Economic Development, continued its geologic and mineral resources evaluation program during the year. A directory of the Mineral Industry in the State was published.³ The directory listed mineral mining and processing operations throughout the State, exclusive of coal mine operations, and included portable plants, some captive and intermittent operations, and some processors of out-of-State or imported materials. A total of 258 companies and individuals on record as of March 15, 1976, were listed. The Division of Mineral Resources also published a quarterly pamphlet,

“Virginia Minerals,” that contains timely and important articles on geology and mineral resources, and an index showing progress of topographic or other mapping in the State. Information articles of particular interest published in 1976 included articles on abandoned copper mines and prospects in the Virgilina District, oil and gas development in Virginia in 1975, and a list of road logs of Virginia geology. Notices of new publications by the Division are also included in the report.

During 1976, the Division of Mineral Resources published seven important

³ LeVan, D. C. Directory of the Mineral Industry of Virginia—1976. Va. Div. Miner. Res. (Charlottesville, Va.), 1976, 55 pp.

studies that were of interest to the mineral industry.⁴

Activities of the Division of Mined Land Reclamation continued at a high level. During the year, 259 operating permits were issued in 7 southwestern counties for coal strip mining operations and 178 operating permits were released. Acreage for coal disturbed totaled 10,084 and acreage reclaimed were 9,508. In reclamation activities, 3.3 million tree seedlings were set out, 836,000 pounds of grass and legumes were planted, and 4.3 million pounds of fertilizer were used as well as nearly 2 million pounds of mulch and 1.5 million pounds of lime.

For minerals other than coal, the reclamation program for the Division of Mined Land Reclamation is administered by an assistant commissioner stationed in Lynchburg. The Division issued 36 operating permits during the year. Noncoal acres disturbed totaled 1,966 and acres reclaimed were 244. Information on materials used in reclamation was not available.

Responsibility for the execution and enforcement of laws enacted for the health and safety of persons employed in Virginia mines and quarries and the enforcement of oil and gas laws is vested in the Division of Mines and Quarries with principal offices in Big Stone Gap. Activities in 1976 consisted of monitoring 985 coal mines and 325 metal and nonmetallic mining and quarrying operations throughout the State. The Division collected information on production, equipment used in the mines, employment, capital expenditures, and other pertinent information on coal and other mining. Other activities consisted of respirable dust monitoring, sound level measurements, sampling for asbestos fibers, detection of toxic gases underground, and investigation of complaints.

Early in the year, the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Zone Management, U.S. Department of Commerce, granted the State \$403,225 for continued planning of Virginia's coastal zone management program, now in the second year of a 3-year effort. The grant will be administered by the Virginia Division of State Planning and Community Affairs. Main objectives during the second-year work program will be to determine the coastal boundary, develop a draft procedure for determining

permissible and priority uses, formulate guidelines on alternate uses for coastal areas of critical concern, define procedures for coordinating development of the coastal program with Federal agencies within Virginia, involve the general public and all levels of Government in designing the program, and prepare a plan outlining the requirements for management program implementation.

Late in the year, the Virginia Institute of Marine Science (VIMS) was granted a \$2.7 million grant by the Federal Bureau of Land Management to conduct oceanographic studies off the coasts of Virginia, Maryland, Delaware, and New Jersey. The studies are to be made in anticipation of development of offshore oil and gas; the award is a continuation of a grant of \$1.7 million made to VIMS in 1975. In conducting the new study, three research ships will be used in areas of high interest for potential oil and gas leasing. The ships will collect various types of data, which will be used as standards in determining the effects of offshore drilling.

Trends and Developments.—Industrial activity in the State in 1976 showed an upward trend and a marked improvement over the preceding year. Announcements of new and expanding manufacturing firms in 1976 totaled 113, with an anticipated or estimated employment of about 10,670 individuals, according to reports by the Virginia Division of Industrial Development. New development activity showed a 48% increase in anticipated employment over 1975. During the year, 26 firms announced

⁴Gathright, T. M., II. Geology of the Shenandoah National Park, Va. Va. Div. Miner. Res. (Charlottesville, Va.), Bull. 86, 1976, 93 pp.

Johnson, G. H. Geology of the Mulberry Island, Newport News North, and Hampton Quadrangles, Va. Va. Div. Miner. Res. (Charlottesville, Va.), RI 41, 1976, 72 pp.

Johnson, S. S. Bouguer Gravity in Virginia 36° 30' to 38° 00' North, 80° 00' to 81° 00'. Va. Div. Miner. Res. (Charlottesville, Va.), RI 43, 1976, 25 pp.

Lukert, M. T., III, and E. B. Nuckols, II. Geology of the Linden and Flint Hill Quadrangles, Va. Va. Div. Miner. Res. (Charlottesville, Va.), RI 44, 1976, 83 pp.

McGuire, O. S. Geology of the Daleville Quadrangle, Va. Va. Div. Miner. Res. (Charlottesville, Va.), RI 42, 1976, 43 pp.

Rader, E. K., and T. H. Biggs. Geology of the Strasburg and Toms Brook Quadrangles, Va. Va. Div. Miner. Res. (Charlottesville, Va.), RI 45, 1976, 104 pp.

Sweet, P. C. Clay Material Resources in Virginia. Va. Div. Miner. Res. (Charlottesville, Va.), Min. Res. Rept. 13, 1976, 56 pp.

investments of \$2 million or more each; some of the firms planned investments for new facilities and some for expansion of existing plants. Among the new facilities announced during the year was the new \$10-\$12 million plant of Citadel Cement Corp. at Chesapeake. The expansion of existing plants included the \$3.5 million expansion of the Lynchburg Foundry, Mead Company, at Archer Creek and with a \$3 million expansion of Reynolds Metal Co. in the Richmond area.

The increased use of electric energy in the State is indicative of an upward trend begun many years ago.

Virginia Electric and Power Co., (VEPCO) continued construction of its nuclear plant in Louisa County. The North Anna Power Station construction included the first of two 934-megawatt units scheduled to go into operation in 1978. With completion of the second unit, the company expects about 50% of its electrical output to come from nuclear sources. Construction of the company's planned Bath County pumped storage project continued during 1976. When completed, this facility will be among the largest in the world. Estimated to cost \$751 million, the facility will have six units with a total generating capacity of 2,100 megawatts. The first three units are scheduled for operation in 1983 and the other three units in 1984.

Virginia's port activity was at a high level, continuing a trend indicative of the increased traffic in coal. According to the Virginia Ports Authority, 3.2 million tons of general cargo moved through the Hampton Roads ports during 1976. The increased activity was substantiated by the fact that 88 cargo ship lines now call at Hampton Roads and load cargo that is taken to 397 foreign ports in 124 countries.

With 5,000 ships sailing from Hampton Roads each year, the utilization of existing berths is nearing maximum limits. Expansions are expected in the future at Norfolk International Terminal, Portsmouth Marine Terminal, and at Newport News.

Employment and Injuries.—According to the "Annual Report for 1976 on Administration of the Federal Metal and Non-metallic Mine Safety Act (Public Law 89-577)," Virginia had 204 active mines and mills throughout the year, exclusive of coal mines. These included 6 underground mines, 24 open pit operations, 116 crushed stone operations, 56 sand and gravel operations, and 2 mills that were inspected as separate entities. These mines and mills employed 4,886 persons: 442 at underground mines and 4,444 at surface mines and mills. The Mining Enforcement and Safety Administration (MESA) personnel made 439 regular inspections, 123 spot inspections, and 1 special inspection. Notices issued totaled 1,396 and notices terminated were 1,242. Orders issued were 43 and orders terminated were 57. Preliminary data indicated that there were 3 fatalities at mines and mills during the year and a total of 107 disabling injuries; there were 34 injuries at underground mines, 51 at surface mines, and 22 at mills.

Virginia continued as one of the five States with a State Plan Agreement with MESA. Under the agreement, the State is required to inspect all active underground mines at least four times per year and each active underground gassy mine a minimum of five times per year. All active surface mines must be inspected at least once per year. MESA maintained a field office at Charlottesville to carry out the terms of the agreement and to conduct necessary inspections and investigations.

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—In terms of mineral production value, coal was again the State's most important mineral commodity, accounting for 83% of the total mineral production value of the State. Total coal output was 40.0 million short tons valued at \$964.7 million, a 13% increase in tonnage but an 11% decrease in value com-

pared with that of the previous year. The average value per short ton was \$24.12 compared to \$30.46 in 1975, a considerable drop in price over the 1-year period. Production data include coal produced from deposits within Virginia, whether the mine opening is or is not inside the State boundary, and exclude operations producing less than 1,000 tons per year. Consequently, production data published by the

Federal Bureau of Mines may differ somewhat from data published by the State of Virginia.

Buchanan, Wise, and Dickenson Counties, as in 1975, accounted for about 83% of the total State production. Buchanan County accounted for about 40% of the State production and led the State in underground output. Wise County, with 31% of the State's production, led in surface mine output.

The total underground output from 399 mines was 26.1 million tons compared with 23.2 million tons from 374 mines in 1975. Total surface output from 396 mines was 13.9 million tons. Underground produc-

tion accounted for 65% of the total State production; the remaining 35% came from surface mines.

Consolidation Coal Co. (Consol) announced plans to reopen a 3,000-ton-per-day underground coal mine near Amonate, Tazewell County. The mine, which also underlies McDowell County, W. Va., was operated by Consol for about 30 years prior to its closing 16 years ago due to poor market conditions. The mine will use continuous-mining equipment and is expected to reach full production of 675,000 tons per year of high-quality, metallurgical-grade coal in 1981.

Table 4.—Virginia: Bituminous coal production in 1976, by type of mine and county
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Underground	Surface	Underground	Surface	
Buchanan -----	238	109	11,584	4,220	NA
Dickenson -----	50	54	3,791	1,508	NA
Lee -----	21	19	630	683	NA
Russell -----	9	19	1,269	439	NA
Tazewell -----	24	14	3,184	399	NA
Wise -----	57	181	5,599	6,691	NA
Total -----	399	396	26,056	13,940	\$964,669

NA Not available by county.

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

The Virginia Division of Mineral Resources continued a field program begun in late 1975 to collect coal samples and geologic information in the southwest Virginia coalfield. Personnel of the Division visited both surface and underground mining operations to obtain representative samples from as many coalbeds as possible. Information from this program will augment current knowledge of the State's coal resources, and the information gathered will also be entered into a computerized system known as the National Coal Resources Data System. This system will permit rapid retrieval of a wide range of information on the Nation's coal resources. The Federal Bureau of Mines will conduct proximate and ultimate analysis on these samples at its coal preparation laboratory in Pittsburgh, Pa., and detailed chemical analyses will be done by the U.S. Geologic Survey.

The Tennessee Valley Authority (TVA) announced early in the year that Virginia would receive a \$650,000 grant to begin a mined land reclamation project on "orphan" coal surface mines. The 5-year project will reclaim nearly 20,000 acres of abandoned strip mines and haulage roads in Dickenson, Lee, Russell, Scott, Tazewell, and Wise Counties. These counties qualify for the program because they are partially or totally in the watershed of the Tennessee River. The project will be conducted by the Virginia Division of Mined Land Reclamation for the State and for TVA by its Division of Forestry, Fisheries, and Wildlife.

Coke.—There was only one coke-producing operation in the State during 1976. Jewell Coal & Coke Co. operated a plant near Vansant, Buchanan County. The coke, produced in machine-drawn ovens, was used principally in blast furnaces. Most of

the coke consumed in the State came from out-of-State sources and was used primarily by foundries.

Natural Gas and Petroleum.—Natural gas production in Virginia in 1976 was 6,937,326 thousand cubic feet valued at \$7.9 million, a 3% increase in output over that of 1975, but more than double in value. Total production was by 7 companies operating 180 wells in 4 counties. According to the 1976 annual report of the Virginia Division of Mines and Quarries, all of the gas was produced in the southwestern part of the State, as shown in the following tabulation:

County	Number of producing wells	Volume produced (thousand cubic feet)
Buchanan ---	99	4,530,276
Dickenson ---	58	1,489,129
Tazewell ---	21	908,209
Wise -----	2	9,712
Total -	180	6,937,326

Columbia Gas Transmission Corp. (Columbia Gas) was the State's leading gas producer with 90 producing wells, 4 more than in 1975. In addition to its own production, Columbia Gas purchased and transported gas produced from 15 wells of Consol-Ray Resources. Consolidated Gas Supply Corp. purchased gas from 35 wells of Ashland Oil, Inc., 6 wells of P & S Oil and Gas Co., and 1 well of Cabot Corp. Kentucky-West Virginia Gas Co. also purchased gas produced from the 31 wells of the Clinchfield Coal Co. Penn Virginia Corp. produced gas for local use from two wells in Wise County during the year.

Drilling of new gas wells dropped sharply in 1976; only 8 new wells were drilled and 3 old wells were deepened, compared to 36 wells drilled during 1975. Total development footage drilled was 24,460 feet and exploratory footage drilled was 18,814 feet. Columbia Gas drilled six wells during the year for a total footage of 31,669 feet. Lee Oil Drilling Co. drilled one well as a deeper pool test in the Rose Hill oilfield of Lee County, and Westinghouse Electric Corp. drilled one exploratory well in Washington County. Both of these wells were plugged and abandoned as dry holes.

There was a considerable amount of natural gas pipeline construction in 1976 in

Buchanan and Dickenson Counties. Columbia Gas laid 14,362 feet of new line in the Haysi gasfield in Buchanan County, and Berea Gathering Co. continued construction on its new line in the Nora gasfield of Dickenson County.

Several companies acquired new leases during the year, but total acreage under lease for oil and gas at yearend was 871,536 acres, compared with 937,933 acres in 1975. The decline in total lease acreage was due to Phillips Petroleum Co. dropping its lease on a large tract of land owned by Clinchfield Coal Co. Of the total acreage under lease, 8% was developed acreage and the remaining 92% was undeveloped acreage.

Crude oil production remained about the same as in 1975. Two companies produced crude oil from seven wells. Most of the production came from five wells in the Rose Hill field and one well in the Ben Hur field, all operated by Robert F. Spear. The remaining production came from one well in Rose Hill field operated by Lee Oil Drilling Co.

NONMETALS

Aplite.—Virginia, as in 1975, was the only aplite-producing State in the Nation. Aplite output declined in quantity from that of 1975, but the value increased. Two companies each operated an open pit mine and plant in central Virginia. The Feldspar Corp. mined aplite ore and processed the material near Montpelier in Hanover County, and IMC Chemical Group, Inc., Industrial Minerals Division, operated a mine and plant near Piney River in Nelson County. Both companies reduced the iron content of the material by magnetic treatment. Most of the aplite was used as an ingredient in the manufacture of glass.

Cement.—Cement production in 1976 remained about the same as the previous year with only slight increases in output and value for portland cement, the principal cement produced. Masonry cement showed a slight decrease in output but a modest increase in value over that of 1975. Citadel Cement Corp. continued operation of its Roanoke plant near Cloverdale and produced both masonry and portland cement from limestone quarried near Haymakertown and also operated a grinding plant near Chesapeake and consumed im-

ported cement clinker as raw material in production of masonry and portland cement. Riverton Corp. produced only masonry cement at its plant near Riverton. The Virginia cement was shipped to consumers primarily in bulk form, with a small amount shipped in containers. Raw materials used, in addition to limestone, were sand, pyrite, mill scale, and gypsum.

Early in the year, Lone Star Lafarge Co., a joint venture of Lone Star Industries, Inc., and LaFarge Fondu International of Paris, France, announced plans for a new \$10 million plant at Chesapeake. This plant will manufacture a calcium aluminate cement for the North American market. Lafarge Consultants Ltd. of Montreal will be responsible for the complete design, engineering, and project management of the new plant.

Clays.—Common clay and shale output increased 5% in both quantity and value over that of 1975. Total production was 862,000 short tons valued at over \$1.2 million, compared with 819,000 short tons valued at \$1.5 million in 1975. Production was by 8 companies at 13 mines in 11 counties. Most of the clay and shale was unprocessed and used in the manufacture of face brick. Other uses were in lightweight aggregate, for the manufacture of structural concrete and concrete block, and for other purposes. Leading companies were General Shale Products Corp., Webster Brick Co., Inc., Weblite Corp., and Brick and Tile Corp. of Lawrenceville. These four companies accounted for 79% of the total output and 80% of the total value of

all common clay and shale produced in the State during 1976.

Gem Stones.—Amateur collectors and rockhounds collected a variety of mineral specimens and semiprecious gems at various locations in the State.

Gypsum.—United States Gypsum Co. continued as the State's only producer of crude gypsum; output and value more than tripled compared with that of 1975. The company operated two mines—the Locust Cove mine in Smyth County and the Plasterco mine and mill in Washington County. In addition to the two mines, U.S. Gypsum operated a plant near Norfolk and processed imported gypsum and anhydrite for use in a variety of products manufactured by the company.

Kyanite.—Virginia continued to lead the Nation in kyanite production, as it has for many years. Production came from two mines in two counties operated by Kyanite Mining Corp. Output and value increased 11% and 19%, respectively, compared with that of 1975. Kyanite Mining Corp. operated the Willis Mountain mine and processing plant near Sprouses Corner, Buckingham County; the company also operated the Baker Mountain mine and processing plant near Darlington Heights, Prince Edward County.

Lime.—Virginia's lime production in 1976 totaled 877,645 short tons valued at \$26.0 million, compared with 705,410 tons valued at \$20.2 million in 1975, an increase of 24% in output and 29% in value. Six companies produced lime in four counties. All of the companies produced quicklime and hydrated lime except one, which produced only quicklime. Leading companies, listed in descending order of output, were Chemstone Corp. in Shenandoah County; and National Gypsum Co. and Virginia Lime Co., both in Giles County. Principal uses for lime were as a metallurgical flux in the BOF steelmaking process, in pulp and paper manufacture, in electric furnace production of steel, and in water purification.

Table 5.—Virginia: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1972 -----	1,634	1,783
1973 -----	1,646	1,886
1974 -----	1,957	2,614
1975 -----	819	1,152
1976 -----	862	1,210

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

Use	1975		1976	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, BOF -----	331,800	\$9,244	417,400	\$12,250
Paper and pulp -----	97,970	2,729	137,900	4,051
Water purification -----	61,930	1,725	86,070	2,590
Steel, open-hearth -----	47,970	1,336	W	W
Steel, electric -----	60,050	1,673	65,070	1,909
Sewage treatment -----	39,970	1,114	47,210	1,462
Construction -----	8,870	242	12,060	370
Agriculture -----	7,590	265	7,600	266
Other uses ¹ -----	49,260	1,864	104,300	3,094
Total ² -----	705,400	20,192	877,600	25,993

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

¹Includes other metallurgy, other chemical uses, sugar refining, tanning, aluminum-bauxite (1976), acid mine water (1976), refractory dolomite (1975), and uses indicated by symbol W.

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

Mica.—Two mica-processing plants adjacent to each other were operated during the year in the Newport News area. Asheville Mica Co. operated a mica-fabricating plant and Mica Co. of Canada, Inc., operated a plate-mica plant.

Nitrogen Compounds.—Allied Chemical Corp., Nitrogen Div., produced ammonia, urea, ammonium nitrate, and ammonium sulfate from natural gas at a plant near Hopewell, Prince George County. The capacity of the plant is rated at 350,000 tons per year of ammonia, and most of the materials produced are used as ingredients in fertilizers.

Perlite.—Johns-Manville Sales Corp., Shenandoah County, expanded perlite from out-of-State sources at its plant near Woodstock. Total quantity produced was about 17,000 tons; was used primarily in the manufacture of roof insulation board. The plant, reporting production to the Federal Bureau of Mines for the first time in 1976, was also in operation in 1975.

Sand and Gravel.—The quantity of sand and gravel produced increased, but value decreased below that of the previous year. Production, excluding industrial sand and gravel, was 10.2 million tons valued at \$23.1 million in 1976 compared with 9.9 million tons valued at \$24.8 million in 1975. Sand and gravel was produced by 98 companies at 109 mines in 41 counties. Leading counties and independent cities, listed in descending order of production, were Henrico, Chesterfield, Virginia Beach (city), King William, and Prince George; these four counties and one city accounted for 61%

of the total State output. There were 59 operations throughout the State that produced less than 25,000 tons, 12 operations that produced from 25,000 to 49,999 tons, 16 operations that produced 50,000 to 99,999 tons, 10 operations that produced 100,000 to 199,999 tons, 11 operations that produced 200,000 to 999,999 tons, and 1 operation that produced in excess of 1 million tons.

Most of the sand and gravel produced was for construction purposes. Only two producers of industrial sand reported production to the Federal Bureau of Mines during the year, compared with five producers in 1975; industrial output increased slightly over that of 1975. There was only one producer of both construction and industrial sand and gravel during the year.

Processed sand and gravel for commercial use was produced by 47 companies. Principal uses were for nonresidential construction purposes, concrete products, fill, roadbase, bituminous paving, highway and bridge construction, other construction such as dams, waterworks, airports, and other uses. The unit value for the processed material ranged from \$1.16 to \$2.85 per ton and averaged \$2.42 per ton. Processed material for Government use produced by 22 companies ranged from \$2.48 to \$3.34 per ton and averaged \$3.08 per ton.

Principal uses for unprocessed sand and gravel were fill, roadbase, and other uses. The average price per ton for commercial use was \$1.49, and for Government use, \$2.00 per ton.

Most of the industrial sand and gravel was unground and used for glass, engine

molding, and other uses. A small amount of sand was ground and used in the manufacture of glass.

(60%), waterway (27%), railroad (12%), and other methods (1%). In addition, a small tonnage of sand and gravel was used at the pit site.

Sand and gravel was transported by truck

Table 7.—Virginia: Sand and gravel sold or used by producers in 1976

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	6,827	\$18,853	\$2.03
Gravel -----	3,865	9,235	2.74
Total ¹ -----	10,191	23,089	2.27
Industrial sand -----	W	W	W

W Withheld to avoid disclosing company proprietary data.

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

Table 8.—Virginia: Construction sand and gravel sold or used by producers in 1976, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	4,187	\$10,689	\$2.55
Concrete products (cement blocks, bricks, pipe, etc.) -----	1,913	5,080	2.66
Asphaltic concrete aggregates and other bituminous mixtures -----	473	986	2.08
Roadbase and coverings -----	1,652	3,806	2.30
Fill -----	1,585	1,849	1.17
Other uses -----	383	678	1.77
Total ¹ -----	10,191	23,089	2.27

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

Stone.—Stone was the leading nonmetallic mineral commodity produced in the State. Total output was 36.1 million tons valued at \$91.7 million, compared with 35.4 million short tons valued at \$84.2 million in 1975, an increase of 2% in output and 9% in value. Virginia led the Nation in output of crushed slate and ranked third in crushed granite and dimension slate.

Crushed stone was produced by 76 companies at 127 quarries for roadbase aggregate, roadstone, concrete, and other uses. Crushed stone accounted for 98% of the State's total stone production value for 1976.

Thirteen counties each produced over 1 million tons of crushed and broken stone. Leading counties were Loudoun, Fairfax, Frederick, Botetourt, and Wythe. Leading producers were Vulcan Materials Co., Luck Quarries, Inc., and Lone Star Industries, Inc. Shipments of crushed and broken stone were 82% by truck, 15% by railroad, and the remaining 3% by other and unspecified methods, including a small tonnage by waterway.

Dimension stone was quarried by 7 companies at 10 operations for roofing, dressed flagging, rough construction, and other uses, from limestone, granite, sandstone, slate, and other material. Output declined 26% to 10,547 tons valued at \$1.8 million. Leading producers were LeSuer Richmond

Slate Co. and Arvonja-Buckingham Slate Co., Inc.

Twenty quarries produced less than 25,000 tons; 12 quarries, 25,000 to 49,999 tons; 14 quarries, 50,000 to 74,999 tons; 5 quarries, 75,000 to 99,999 tons; 20 quarries, 100,000 to 199,999 tons; 16 quarries, 200,000 to 299,999 tons; 16 quarries, 300,000 to 399,999; 10 quarries, 400,000 to 499,999 tons; 15 quarries, 500,000 to 899,999 tons; and 7 quarries, over 900,000 tons.

Sulfur.—Amoco Oil Co. continued operation of the only oil refinery located in Virginia. Hydrogen sulfide, recovered from fuel gas, was converted to elemental sulfur at its Yorktown refinery, York County. Total output decreased 12% and value decreased 29%, compared with that of 1975. According to the firm's annual report, construction began during the year on additional wastewater treatment at the Yorktown refinery.

Table 9.—Virginia: Crushed stone¹ sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dense-graded roadbase stone -----	12,299	26,168	12,120	28,220
Roadstone -----	6,456	14,050	5,161	12,060
Concrete aggregate -----	5,355	12,330	4,950	12,320
Bituminous aggregate -----	2,630	6,140	3,967	9,587
Surface treatment aggregate -----	1,397	3,159	2,323	5,547
Agricultural limestone -----	1,601	4,635	1,882	6,062
Lime manufacture -----	1,524	3,442	1,664	3,749
Cement manufacture -----	1,226	2,257	1,340	2,602
Macadam aggregate -----	464	998	537	1,174
Mine dusting -----	425	1,262	422	1,534
Railroad ballast -----	697	1,343	346	751
Flux stone -----	211	430	345	804
Other filler -----	W	W	141	725
Riprap and jetty stone -----	124	439	136	472
Bedding material -----	--	--	10	25
Soil conditioning -----	6	13	5	9
Filter stone -----	40	79	W	W
Other uses ² -----	914	5,310	770	4,319
Total ³ -----	35,369	82,058	36,121	89,965

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

¹ Includes limestone, granite, traprock, sandstone, slate, other stone, marble, marl, and shell.

² Includes stone used in lightweight aggregate, glass, mineral food, asphalt filler, slate flour, roofing granules, terrazzo and exposed aggregate, chemicals, abrasives (1976), fill, paper (1975), unspecified uses, and uses indicated by symbol W.

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

Talc (Soapstone).—Blue Ridge Talc Co., Inc., was the only firm in the State reporting production during the year. Output increased slightly compared with that of 1975 and value doubled. The material was produced at the firm's quarry in Franklin County and processed by grinding at the company's plant in Henry County. Most of the processed talc was used in foundry facings and insecticides.

METALS

Ferroalloys.—Chemstone Corp., a subsidiary of Engelhard Minerals & Chemicals Corp., produced ferrovandium from im-

ported and domestic materials at its plant near Strasburg, Shenandoah County. Chemstone also operated a limestone quarry and a lime plant.

Iron Ore.—Huff Coal and Oil Co., Pulaski County, recovered byproduct iron ore in the form of iron cinder from Allied Chemical Corp.'s pyrrhotite-processing plant near Pulaski. Shipments increased over those of 1975. Most of the material was used as raw material in cement manufacture.

Iron Ore Oxide Pigments.—Three companies in two counties produced finished iron oxide pigments in the State during 1976. Total quantity sold was 8,255 short tons valued at \$2.2 million, an increase over

that sold in 1975. Blue Ridge Talc Co., Inc., Henry County, produced finished iron oxide pigments from hematite from out-of-State sources. Hercules, Inc., Pulaski County, produced synthetic iron oxides.

Hoover Color Corp. near Hiwassee, Pulaski County, produced finished iron oxide pigments from local deposits of earthy forms of hydrous and anhydrous iron oxides, including ocher, sienna, and umber. Hoover also produced mixtures of natural and synthetic pigments. Finished

iron oxide pigments are used in printing inks, in the manufacture of paint and cement, and in a variety of products where coloring agents are employed.

Lead and Zinc.—Lead and zinc were mined by a single company in Wythe County. Lead production continued a decline evident in 1975; output decreased 24% and value, 18%, compared with that of 1975; zinc production decreased 26% and value, 30%.

Table 10.—Virginia: Mine production of recoverable lead and zinc

Year	Lead		Zinc	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands) ¹
1972 -----	3,441	\$1,034	16,789	\$5,960
1973 -----	2,637	859	16,683	6,894
1974 -----	3,106	1,398	17,195	12,346
1975 -----	2,551	1,097	15,151	11,818
1976 -----	1,946	899	11,241	8,319

¹ Recoverable zinc valued at the yearly average price of prime western-slab zinc, East St. Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of the ore at the mine.

Magnetite.—Virginia Lime Co., a subsidiary of the Rangaire Corp., operated a magnetite-grinding plant near Kimballton, Giles County, using magnetite from out-of-State sources. The processed magnetite was used in coal preparation.

Manganese.—Union Carbide Corp., Battery Products Div., operated a processing plant of manganese ore near Newport News. The manganese ore processed was imported and the finished material was used in batteries and other products manufactured by the company.

Pyrrhotite.—Allied Chemical Corp., Industrial Chemicals Div., mined pyrrhotite near Galax and processed the material in its plant near Pulaski. Iron cinder resulting from the processing of the pyrrhotite is being recovered by Huff Oil and Coal Co. at its Pulaski plant.

Silver.—A small amount of byproduct silver was recovered from the smelting of lead and zinc ores mined by a metals-producing company in Wythe County. Output and value decreased compared with that of 1975.

Table 11.—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.
IMC Chemical Group, Inc -	Box 38 Piney River, Va. 22964	----do -----	Nelson.
Cement:			
Citadel Cement Corp. ¹ ----	Box 27 Cloverdale, Va. 24077	----do -----	Botetourt.
Citadel Cement Corp -----	Box 5128 Chesapeake, Va. 23320	Plant -----	Chesapeake (city).
Riverton Corp. ³ -----	Riverton, Va. 22651 -----	Quarry and plant	Warren.
Clays (miscellaneous and shale):			
Brick and Tile Corp. of Lawrenceville.	Box 45 Lawrenceville, Va. 23868	Pits and plant ----	Brunswick and Greensville.
General Shale Products Corp.	Box 3547 Johnson City, Tenn. 37601	----do -----	Smyth and Tazewell.
Old Virginia Brick Co., Inc.	Box 508 Salem, Va. 24153	----do -----	Montgomery and Roanoke.
Webrite Corp -----	Box 12887 Roanoke, Va. 24004	Pit and plant ----	Botetourt.
Webster Brick Co., Inc ----	----do -----	Pits -----	Botetourt and Orange.
Coal (bituminous):			
Clinchfield Coal Co. ³ ----	Dante, Va. 24237 -----	Underground mines	Buchanan, Dickenson, Russell.
Island Creek Coal Co -----	Box 113 Keen Mountain, Va. 24264	----do -----	Buchanan.
Westmoreland Coal Co ----	Box 229 Big Stone Gap, Va. 24219	----do -----	Wise.
Coke:			
Jewell Coal & Coke Co ----	Dismal Route, Box 1 Vansant, Va. 24656	Plant -----	Buchanan.
Ferrous alloys:			
Chemstone Corp. ⁴ -----	Box 71 Strasburg, Va. 22657	----do -----	Shenandoah.
Gypsum:			
United States Gypsum Co --	Box 4686 Norfolk, Va. 23523	----do -----	Norfolk (city).
Do -----	Route 1 Saltville, Va. 24370	Mines and plant --	Smyth and Washington.
Iron oxide pigments (crude):			
Blue Ridge Talc Co., Inc --	Box 39 Henry, Va. 24102	Plant -----	Henry.
Hoover Color Corp -----	Box 218 Hiwassee, Va. 24347	Mine and plant ----	Pulaski.
Lime:			
Battery Park Fish and Oyster Co.	Box 57 Battery Park, Va. 23304	Plant -----	Isle of Wight.
Chemstone Corp -----	Box 71 Strasburg, Va. 22657	----do -----	Shenandoah.
The Flintkote Co -----	Box 3 Stephens City, Va. 22655	----do -----	Frederick.
W. S. Frey Co., Inc -----	Box 65 Clearbrook, Va. 22624	----do -----	Do.
National Gypsum Co -----	Star Route 635 Ripplemead, Va. 24150	----do -----	Giles.
Virginia Lime Co -----	Star Route Ripplemead, Va. 24150	----do -----	Do.
Perlite, expanded:			
Johns-Manville Sales Corp -	Box 442 Woodstock, Va. 22644	----do -----	Shenandoah.
Sand and gravel:			
Friend Sand & Gravel Co., Inc.	Box 5607 Virginia Beach, Va. 23455	----do -----	Chesterfield and Prince George.
Lone Star Industries, Inc --	Box 3778 Richmond, Va. 23229	Pits -----	Charles City, Chesterfield, Henrico, New Kent, Prince George.
Solite Corp -----	Box 883 Fredericksburg, Va. 22401	Pit -----	King George.
West Sand & Gravel Co., Inc.	Box 6008 Richmond, Va. 23222	Pits -----	Henrico and Rockingham.
E. V. William Co., Inc ----	Box 938 Norfolk, Va. 23501	Pit -----	Virginia Beach (city).

See footnotes at end of table.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone:			
Koppers Co., Inc -----	Box 650 Culpeper, Va. 22701	Mine and plant ---	Culpeper, Hanover, Rappahan- nock, Spotsyl- vania.
Lone Star Industries, Inc --	977 Norfolk Square Norfolk, Va. 23501	Quarries -----	Brunswick, Chesterfield, Dinwiddie.
Luck Quarries, Inc -----	Box 4682 Richmond, Va. 23229	---do -----	Albemarle, Augusta, Fairfax, Goochland, Loudoun, Nottoway.
Pounding Mill Quarry Corp.-	Box 2459 Roanoke, Va. 24010	---do -----	Tazewell.
Vulcan Materials Co -----	Box 7506 Reynolds Station Winston Salem, N.C. 27109	---do -----	Brunswick, Chesterfield, Fairfax, Goochland, Halifax, Mecklen- burg, Pitt- sylvania, Prince William, Rocking- ham, Wash- ington.
Talc (soapstone):			
Blue Ridge Talc Co., Inc --	Box 39 Henry, Va. 24102	Mine and plant ---	Franklin.

¹ Also clays, sand and gravel, and stone.² Masonry cement only; also produces limestone.³ Also clays.⁴ Also lime.

The Mineral Industry of Washington

This chapter has been prepared under a cooperative agreement 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 minerals.

By John R. Welch ¹

The value of mineral production in Washington rose to a record high of \$187.2 million in 1976, 18% more than in 1975. Nonmetals (including cement) accounted for nearly two-thirds of the value, and metals accounted for a substantial part of the balance. The value of nonmetals was \$119.3 million, up 18%

compared with that in 1975, largely because of higher prices. Fuels, consisting solely of coal, also showed an increase in value; the value of cement increased 20% over that of 1975; and there was an increase in the value of most metals.

¹State Liaison Officer, Bureau of Mines, Olympia, Wash.

Table 1.—Mineral production in Washington ¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry -----thousand short tons--	5	\$209	6	\$834
Portland -----do-----	1,147	40,666	1,238	48,669
Clays ² -----do-----	290	778	381	1,141
Coal (bituminous) -----do-----	3,743	W	4,109	W
Gem stones -----do-----	NA	160	NA	168
Peat -----thousand short tons--	13	98	14	103
Sand and gravel -----do-----	19,069	32,990	19,813	36,017
Stone -----do-----	7,920	18,754	10,223	24,091
Value of items that cannot be disclosed:				
Clays (fire), coal, copper, diatomite, gold, gypsum, lead, lime, olivine, silver, talc, tungsten, uranium, zinc and values indicated by symbol W -----	XX	64,850	XX	76,699
Total -----	XX	158,505	XX	187,222
Total 1967 constant dollars -----	XX	62,720	XX	P 67,306

P Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data; included with "Value of items that cannot be disclosed." XX Not available.

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

² Excludes fire clay; included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in Washington, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams -----	W	W	Sand and gravel, stone.
Asotin -----	\$87	\$80	Stone, sand and gravel.
Benton -----	W	W	Do.
Chelan -----	359	715	Sand and gravel.
Challam -----	W	W	Stone, clays, sand and gravel.
Clark -----	W	784	Sand and gravel, stone, clays.
Columbia -----	101	687	Stone.
Cowhitz -----	1,023	909	Stone, sand and gravel.
Douglas -----	W	2,300	Stone, sand and gravel, clays.
Ferry -----	4,850	3,821	Gold, silver, stone, zinc, copper, sand and gravel, lead.
Franklin -----	129	W	Stone, sand and gravel.
Garfield -----	51	39	Stone.
Grant -----	W	W	Diatomite, lime, stone, sand and gravel.
Grays Harbor -----	1,023	W	Sand and gravel, stone.
Island -----	428	306	Sand and gravel.
Jefferson -----	832	W	Stone, sand and gravel.
King -----	W	W	Cement, sand and gravel, stone, coal, clays, peat.
Kitsap -----	W	W	Sand and gravel, peat, stone.
Kittitas -----	W	W	Stone, sand and gravel, clays.
Klickitat -----	248	292	Stone, sand and gravel.
Lewis -----	W	W	Coal, sand and gravel, stone.
Lincoln -----	175	W	Sand and gravel, stone.
Mason -----	W	W	Do.
Okanogan -----	302	321	Sand and gravel, stone, gypsum, gold, silver, copper, lead, zinc.
Pacific -----	252	251	Stone.
Pend Oreille -----	14,009	17,914	Zinc, cement, lead, stone, sand and gravel, silver, copper, gold.
Pierce -----	W	W	Sand and gravel, lime, stone, clays.
San Juan -----	W	W	Sand and gravel.
Skagit -----	2,886	W	Olivine, stone, sand and gravel, talc.
Skamania -----	445	634	Stone, sand and gravel.
Snohomish -----	W	W	Sand and gravel, stone, clays.
Spokane -----	W	W	Sand and gravel, stone, clays, peat.
Stevens -----	9,502	9,495	Uranium, stone, sand and gravel, clays, tungsten, silver, copper, lead.
Thurston -----	16,263	W	Coal, sand and gravel, peat, stone.
Wahkiakum -----	W	W	Stone.
Walla Walla -----	W	W	Sand and gravel.
Whatcom -----	W	W	Cement, sand and gravel, stone, clays.
Whitman -----	239	W	Stone.
Yakima -----	W	580	Stone.
Undistributed ¹ -----	105,816	148,088	Sand and gravel, stone, lime.
Total ² -----	158,505	187,222	

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

¹ Includes value of mineral production 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 Washington business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands--	1,532.0	1,587.0	+ 3.6
Unemployment ----- do-----	146.0	137.0	- 6.2
Employment (nonagricultural):			
Mining ----- do-----	2.0	2.1	+ 5.0
Manufacturing ----- do-----	244.0	246.1	+ .9
Contract construction ----- do-----	59.5	67.2	+ 12.9
Transportation and public utilities ----- do-----	72.5	75.1	+ 3.6
Wholesale and retail trade ----- do-----	285.6	306.0	+ 7.1
Finance, insurance, real estate ----- do-----	65.0	68.0	+ 4.6
Services ----- do-----	216.6	230.4	+ 6.4
Government ----- do-----	273.6	272.9	- .3
Total nonagricultural employment ----- do-----	¹ 1,218.3	1,267.8	+ 4.1
Personal income:			
Total ----- millions--	\$22,341	\$24,569	+ 10.0
Per capita ----- do-----	\$6,277	\$6,802	+ 8.4
Construction activity:			
Number of private and public residential units authorized	35,209	47,883	+ 36.0
Value of nonresidential construction ----- millions--	\$349.8	\$431.0	+ 23.2
Value of State road contract awards ----- do-----	\$135.0	\$205.0	+ 51.9
Shipments of portland and masonry cement to and within the State ----- thousand short tons--	1,039	1,177	+ 13.3
Mineral production value:			
Total crude mineral value ----- millions--	\$158.5	\$187.2	+ 18.1
Value per capita, resident population ----- do-----	\$45	\$52	+ 15.6
Value per square mile ----- do-----	\$2,324	\$2,745	+ 18.1

^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.

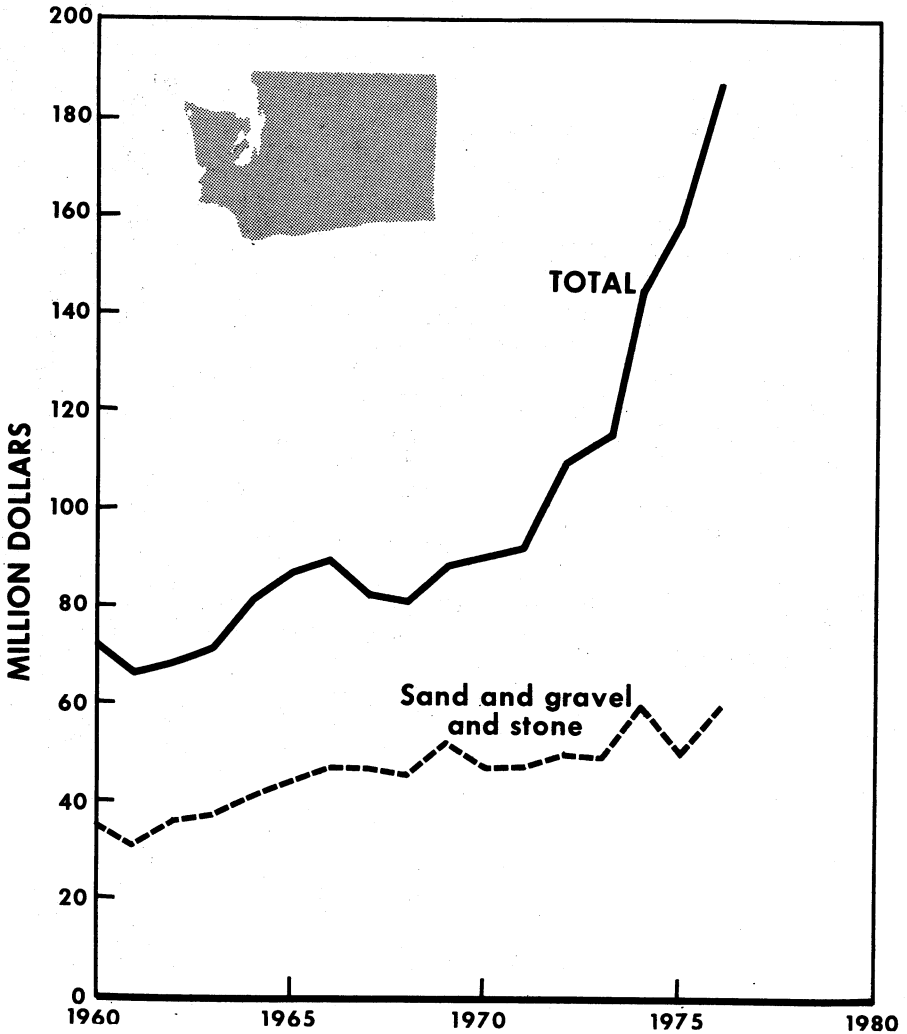


Figure 1.—Value of sand and gravel and stone, and total value of mineral production in Washington.

The experimental coal liquefaction plant at Fort Lewis, completed its first assignment, that is, the production of 3,000 tons of solvent-refined coal. This material, produced in solid form, was shipped elsewhere, where it apparently met all emission tests satisfactorily. The plant is presently producing a liquid form of the material, more highly hydrogenated, and that has a lower boiling point. It could be classified as a residual oil or a middle dis-

tillate, comparable with a No. 6 oil. By September 1977, the plant will again revert to producing the solid form, using other than Kentucky coals.

At that time too, a decision will be made regarding future operations, with one possibility being the construction of a large demonstration plant that would handle 6,000 tons of coal per day, instead of the present 50-ton-per-day pilot plant. A commercial plant would refine perhaps 30,000

tons of coal per day. At the present time, there are 180 people working at the operation.

Even though Washington is not a large producer of crude minerals, the total mineral industry was a large contributor to the State's economy. There are seven aluminum plants in the State that largely depend upon alumina from Jamaica and Australia. These seven plants produced about 27% of the primary aluminum in the entire Nation. Production increased in 1976 about 7% over that of 1975, and value increased about 20% to more than \$1 billion. Petroleum refining is another large contributor to the economy. There are four large and two smaller refineries located in the northwestern part of the State. Products from these refineries had a gross value of more than \$803 million during 1976. ASARCO Inc.'s nonferrous smelter in Tacoma refined ores from all over the world, and added another \$200 million to the economy of the State. This smelter produces about 6.5% of the Nation's copper, plus gold, silver, and arsenic.

Legislation and Government Programs.—No legislative actions were implemented during the year that had any significant influence on the State's minerals industry.

Environment.—The future of ASARCO's smelter in Tacoma seems uncertain pending determination of air pollution control requirements. As a result of testimony presented at hearings, ASARCO was granted a 5-year variance which postponed compliance with sulfur dioxide emission standards, and arsenic emissions for a shorter term, by the Puget Sound Air Pollution Control Board. This variance was immediately challenged in a lawsuit which was filed in King County Superior Court by individuals and medical and social organizations. The lawsuit sought a court order to force the agency to enforce air pollution regulations against the smelter. This appeal was postponed until January 1977.

During the year, legislation was passed creating a 393,000-acre Alpine Lakes Wilderness area despite opposition from agencies within the Government.

REVIEW BY MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of portland cement increased by about 8% and value increased to \$48.7 million, up about 20% over the value in 1975. Masonry cement shipments increased 20% and value increased to \$334,000, up 60% over the 1975 value. Output originated at four plants.

Ready-mix concrete and concrete product manufacturers, building material dealers, and contractors were the major consumers.

Clays.—Production increased 31% in quantity and 47% in value over that of 1975. Clays were produced in 10 counties, but 3 counties accounted for 82% of total production. Fire clay was produced in only two counties.

Gypsum.—Argo Minerals, Inc., mined gypsum at Poison Lake mine in Okanogan County. Output remained the same as the 1975 production. Kaiser Gypsum Co., Inc., calcined gypsum in King County.

Lime.—Domtar Chemicals, Inc., and Utah-Idaho Sugar Co. produced lime in Grant, Pierce, and Yakima Counties for sugar refining, paper and pulp processing, calcium carbide production, sewage treatment, and other uses. Output increased in quantity and value over that of 1975.

Sand and Gravel.—The total quantity of sand and gravel produced in 1976 increased 4% over that produced in 1975. The value of production increased 9%.

Thirty-four counties reported production, but Pierce, King, Snohomish, San Juan, and Thurston Counties produced 63% of the total.

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

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value ¹	Quantity	Value ¹
Construction:				
Processed:				
Sand -----	3,559	6,777	8,656	9,678
Gravel -----	10,031	18,358	10,954	24,885
Unprocessed:				
Sand and gravel -----	5,479	5,847	—	—
Industrial sand -----	W	W	203	1,455
Total -----	19,069	30,982	19,813	² 36,017

W Withheld to avoid disclosing individual company confidential data; included with "Construction."

¹ Value f.o.b. plant per ton of processed sand and per ton of processed gravel. Values in all other tables are f.o.b. plant for blended processed sand and gravel used as construction aggregate. Unit value of construction aggregate is generally higher than the unit value of unblended processed sand or gravel.

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

Table 5.—Washington: Construction aggregate (blended sand and gravel) and industrial sand and gravel sold or used commercially by producers

(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Processed:				
Concrete aggregate (residential, non-residential, highways, bridges, dams, waterworks, airports, etc.) -----	6,126	11,337	5,838	12,487
Concrete products (cement blocks, bricks, pipe, etc.) -----	905	2,346	2,532	5,269
Asphaltic concrete aggregates and other bituminous mixtures -----	1,199	2,248	2,085	4,563
Unprocessed:				
Roadbases and coverings -----	1,136	2,372	4,097	5,882
Fill -----	464	773	4,638	5,506
Other uses ¹ -----	3,818	4,759	419	856
Total ² -----	13,648	23,835	19,610	34,562

¹ Includes unprocessed roadbase and subbase fill, and industrial sand and gravel.

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

Stone.—Nine companies quarried dimension stone for cut building stone, rough construction, rubble, and other uses. Output increased 18% to 5,208 tons valued at \$476,900. Leading dimension stone producers were Wilkeson Cut Stone Co. and Smith Limestone Co.

Crushed stone was produced by 88 companies at 253 quarries for surface treat-

ment aggregate, roadstone, riprap, and other uses. Output expanded 29% to 10.2 million tons valued at \$23.6 million. Among the leading producers were the U.S. Forest Service and the State Highway Department.

Among the States, Washington ranked second in output of dimension traprock and third in crushed traprock.

Table 6.—Washington: Stone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Dimension stone total -----	4	326	5	477
Crushed and broken:				
Bituminous aggregate -----	621	1,393	780	1,935
Concrete aggregate -----	86	173	W	W
Dense-graded roadbase stone -----	1,043	2,091	1,285	2,397
Macadam aggregate -----	54	148	123	323
Surface treatment aggregate -----	2,167	4,480	2,191	5,305
Unspecified construction aggregate and roadstone -----	1,686	3,958	2,100	4,892
Agricultural limestone -----	10	W	17	192
Fill -----	18	36	224	240
Flux stone ¹ -----	W	W	W	W
Glass -----	134	1,098	W	W
Railroad ballast -----	185	372	W	W
Riprap and jetty stone -----	1,055	2,287	1,689	3,306
Other uses ² -----	858	2,391	1,809	5,024
Total ³ -----	7,916	18,428	10,218	23,614

W Withheld to avoid disclosing individual company confidential data; included with "Other uses."

¹ Includes ferrosilicon.

² Include terrazzo, cement manufacture, abrasive, asphalt filler, drain fields, magnesium metal, paper manufacture, roof aggregate, and uses not specified.

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

METALS

Aluminum.—Primary aluminum production in the State increased 7% in 1976, compared with that of 1975, and value increased 20%. Washington's share of national production was 27%, about 1% less than in 1975. Output came from seven plants producing aluminum from alumina imported primarily from Australia.

The aluminum industry in the State was concerned that long-term electric contracts were about to lapse, and their loss could mean that the aluminum industry would be forced out of the Northwest. Low-cost hydroelectric power is beginning to be a thing of the past, and it was the low-cost electric power that brought the aluminum industry to the Northwest in the first place. This remains a question yet to be solved.

Table 7.—Washington: Primary aluminum plant production data

Year	Production			Average U.S. ingot price per pound (cents)
	Quantity (thousand short tons)	Percent of national total	Value (thousands)	
1972 -----	1,049	25	\$532,678	† 26.3
1973 -----	1,048	23	513,732	† 25.3
1974 -----	1,178	24	713,175	† 34.1
1975 -----	1,075	28	847,908	† 39.8
1976 -----	1,150	27	1,021,662	44.6

† Revised.

Copper.—Production of copper increased 27% over that in 1975. However, exploration has increased with the largest single concentration of companies working in the southern Cascades.

To the north in Snohomish County, Cities Service Mineral Corp. commenced diamond drilling on its Silver Creek copper-molybdenum prospect near Index. Bren Mac continued full-scale underground exploration of its copper-molybdenum-tungsten deposit at the Sunrise mine near Monte Cristie. Other exploration continued in Okanogan, Chelan, and Stevens Counties.

Gold and Silver.—There has been a substantial reduction in the number of companies and individuals known to be actually prospecting for gold and silver in Washington. However, despite this decline in prospecting activity from the previous year, interest in precious metals remains moderately strong.

In Ferry County, the Knob Hill mine at Republic continued as the State's only full-time operating gold mine. A few miles west of Republic, Houston Oil and Gas has been drilling for gold at the old Flag Hill mine. In the Sherman district, Canadian interests reexamining the silver deposits around the Silver Belle mine, and north of Republic, Ruby Mining Co. has undertaken development and exploration of the old Valley mine. South of Wenatchee, Cyprus Mines Corp. has enlarged its mineral land holdings around the Gold King mine.

Lead and Zinc.—Production of lead exceeded that of 1975 by 10%, and value increased about 18%. Zinc production increased about 25% above the 1975 production, and value increased by about 18%.

The Pend Oreille mine, located in Pend Oreille County, is the State's largest producer of lead and zinc. This mine is totally owned by The Bunker Hill Co. of Idaho, which in turn, is a wholly owned subsidiary of Gulf Resources and Chemical Co.

The Pend Oreille mine is in the Middle Cambrian Metaline Limestone area, near Metaline Falls. Bunker Hill is also carrying out exploration and feasibility studies nearby at the Yellowhead mine.

Magnesium.—Northwest Alloys, Inc.'s large magnesium and silicon plant was completed in late 1975. Costing more than

\$50 million, the plant was scheduled to produce its first ferrosilicon and magnesium in early 1976. The plant covers about 240 acres near Addy, about 60 miles north of Spokane, and eventually it is expected to have a payroll of about 350. Rated magnesium production capacity for the plant is 24,000 tons per year. Output is derived from dolomite mined near the plant. The plant also has a rated capacity of 16,000 tons annually of silicon, to be derived from quartzite mined in nearby areas.

Uranium.—Western Nuclear, Inc. (WNI) appears to be going ahead with plans to open up its large low-grade uranium ore body on the Spokane Indian Reservation. Production is expected to start in 1978, and when completed, the new \$40 million mill is expected to produce 1 million pounds of U_3O_8 annually. WNI is a subsidiary of Phelps-Dodge Corp. The Sherwood mine is said to have proven ore reserves of 12.5 million pounds of recoverable uranium oxide. The Spokane Indian Reservation has been the site of increased activity in the search for uranium in the last year. Midnite Mines, WNI, Evergreen Mining, Solar Silver, and several others have all negotiated leases on the reservation.

Midnite Mines, the only producer so far, just renegotiated its lease and has entered an exploration agreement with Dawn Mining Co. to increase its reserves. Dawn Mining is 51% owned by Newmont Mining Co., and Midnite Mines holds the other 49%.

MINERAL FUELS

Coal.—Bituminous coal production increased about 10% over that of 1975. Practically all of the production came from one mine, Washington Irrigation and Development Co.'s strip mine in Lewis County. The coal is used exclusively at the 1,400-megawatt coal-fired generating plant in Centralia.

Peat.—Peat production increased 8% in quantity over that produced in 1975, and increased 5% in value during the same period. King County was the largest producing county, followed by Pierce and Thurston Counties. The average value of the peat sold was \$7.36 per ton. The material was sold for use in soil improvement.

Petroleum and Natural Gas.—Preparations were being made for fairly large-scale exploration and drilling for oil and gas in four central Washington counties. Thirty-

five oil and gas development leases covering 30,000 acres in Grant, Yakima, Kittitas, and Benton Counties were issued to Texaco, Inc., Shell Oil Co., and others.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
NONMETALS			
Cement:			
Filtrol Corp. ¹ -----	Marietta Rd., Box 37 Bellingham, Wash. 98225	Plant -----	Whatcom.
Ideal Basic Industries, Inc. ^{1,2,3}	420 Ideal Cement Bldg. Denver, Colo. 80202	---do -----	King.
Lehigh Portland Cement Co. ¹	718 Hamilton St. Allentown, Pa. 18105	---do -----	Pend Oreille.
Lone Star Industries, Inc. --	One Greenwich Plaza Greenwich, Conn. 06830	---do -----	King.
Clays:			
Interpace Corp -----	2901 Los Feliz Blvd. Los Angeles, Calif. 90039	Pit and plant ----	King and Spokane.
Mutual Materials Co -----	Box 3547 Seattle, Wash. 98124	---do -----	King and Pierce.
Diatomite:			
Witco Chemical Corp -----	277 Park Ave. New York, N.Y. 10017	Mine and plant ---	Grant.
Gypsum:			
Agro Minerals, Inc -----	Box Call Tonasket, Wash. 98855	Plant -----	Okanogan.
Lime:			
Domtar Chemicals, Inc ----	1220 Alexander Ave. Tacoma, Wash. 98431	---do -----	Pierce.
Olivine:			
Northwest International ---	329 Kincaid Mount Vernon, Wash. 98273	Mine and plant ---	Skagit.
Pumice:			
W. L. Marenakos Co -----	Route 1, Box 921 Issaquah, Wash. 98027	Plant -----	Kittitas.
Sand and gravel:			
Associated Sand & Gravel Co., Inc.	Box 2037 Everett, Wash. 98201	Pit and plant ----	Snohomish.
B & L Trucking & Con- struction Co.	1621 Marineview Dr. Tacoma, Wash. 98422	---do -----	Pierce.
Central Pre-Mix Concrete -	805 North Division St. Spokane, Wash. 99202	---do -----	Adams, Franklin, Spokane.
Glacier Sand & Gravel Co.--	5975 East Marginal Way Seattle, Wash. 98134	---do -----	King and Pierce.
Lakeside Gravel Co -----	Box 46 Issaquah, Wash. 98027	---do -----	King.
Stoneway Concrete, Inc ---	Box 509 Renton, Wash. 98055	---do -----	Do.
Woodworth & Co., Inc ----	1200 East D St. Tacoma, Wash. 98421	---do -----	Pierce.
Silicon carbide:			
The Carborundum Co -----	P.O. Box 423 Niagra Falls, N.Y. 14302	Plant -----	Clark.
Stone:			
Black River Quarry, Inc --	6808 South 140th Seattle, Wash. 98178	Quarry -----	King.
Friend & Rikals, Inc -----	Box 3 Aberdeen, Wash. 98520	---do -----	Grays Harbor.
General Construction Co --	Box 3845 Seattle, Wash. 98124	Quarry and plant--	Jefferson.
Lane Mountain Silica Inc -	Route 1 Valley, Wash. 99181	Quarry -----	Stevens.
Stoen Construction Co ----	Box 488 Monroe, Wash. 98272	---do -----	Snohomish.
Woodworth & Co., Inc ----	1200 East D St. Tacoma, Wash. 98421	---do -----	Pierce.
Sulfuric acid, smelter:			
American Smelting and Refining Co.	Box 1605 Tacoma, Wash. 98401	Plant -----	Do.

See footnotes at end of table.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
NONMETALS—Continued			
Talc and soapstone:			
Cascade Minerals, Inc -----	3314 Harbor Ave., SW. Seattle, Wash. 98126	Quarry -----	Skagit.
Skagit Talc Co -----	220 Reed St. Sedro Wooley, Wash. 98284	----do -----	Do.
Vermiculite (exfoliated):			
Vermiculite-Northwestern, Inc.	Box A Auburn, Wash. 98002	Plant -----	Spokane.
METALS			
Aluminum:			
Aluminum Company of America.	Vancouver, Wash. 98600	----do -----	Chelan and Clark.
Intalco Aluminum Corp ----	Wenatchee, Wash. 98801	----do -----	Whatcom.
Kaiser Aluminum & Chemical Corp.	Bellingham, Wash. 98225	----do -----	Pierce and Spokane.
Martin Marietta Corp ----	Spokane, Wash. 99200	----do -----	Klickitat.
Reynolds Metals Co -----	Tacoma, Wash. 98400	----do -----	
	Rockville, Md. 20852	----do -----	
	Longview, Wash. 98620	----do -----	Cowlitz.
Ferroalloys:			
Hanna Mining Co -----	Wenatchee, Wash. 98901	----do -----	Douglas.
Northwest Alloys, Inc	Addy, Wash. 99101	Plant and mine	Stevens.
Ohio Ferro-Alloys Corp	Tacoma, Wash. 98400	Plant	Pierce.
Gold:			
Knob Hill Mines, Inc. ³ ----	160 Sansome St. San Francisco, Calif. 94104	Mine and mill	Ferry.
Lead-zinc:			
The Bunker Hill Co. (Pend Oreille Mine).	Kellogg, Idaho 83837	----do -----	Pend Oreille.
Magnesium:			
Northwest Alloys, Inc ----	Addy, Wash. 99101	Plant and mine	Stevens.
Steel:			
Bethlehem Steel Co -----	Bethlehem, Pa. 18016	Plant -----	King.
Northwest Steel Rolling Mills, Inc.	Seattle, Wash. 98107	----do -----	Do.
Uranium:			
Dawn Mining Co -----	Box 25 Ford, Wash. 99013	Mine and mill	Stevens.
MINERAL FUELS			
Coal:			
Washington Irrigation and Development Co.	Route 2, Box 41 Centralia, Wash. 98531	Strip mine	Lewis.
Peat:			
Maple Valley Humus -----	18805 SE. 170th St. Renton, Wash. 98055	Bog -----	King.
Plant Food Co -----	14515 35th Ave. Bothell, Wash. 98011	Bog -----	Snohomish.
Petroleum refineries:			
Atlantic Richfield Co ----	Ferndale, Wash. 98248	Plant -----	Whatcom.
Mobile Oil Corp -----	----do -----	----do -----	Do.
Shell Oil Co -----	Anacortes, Wash. 98221	----do -----	Skagit.
Sound Refining, Inc -----	Tacoma, Wash. 98400	----do -----	Pierce.
Texaco, Inc -----	Anacortes, Wash. 98221	----do -----	Skagit.
U.S. Oil & Refining Co ----	Tacoma, Wash. 98400	----do -----	Pierce.

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

The Mineral Industry of West Virginia

This chapter has been prepared under a cooperative agreement between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey.

By Grace N. Broderick¹

In 1976 the value of mineral production in West Virginia was \$3.5 billion, an increase of 3% over that of 1975. Coal accounted for \$3.3 billion or 94% of the value of all minerals produced. West Virginia ranked second only to Kentucky in total

U.S. production of bituminous coal, supplying about 16% of the Nation's production. The State ranked third in dollar value of overall U.S. mineral production.

¹ State Liaison Officer, Bureau of Mines, Charleston, W. Va.

Table 1.—Mineral production in West Virginia¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ²thousand short tons..	278	\$439	275	\$463
Coal (bituminous).....do.....	109,283	3,206,951	108,834	3,278,180
Gem stones.....do.....	NA	2	NA	2
Natural gas.....million cubic feet..	154,484	57,005	153,322	87,394
Petroleum (crude).....thousand 42-gallon barrels..	2,479	29,712	2,519	30,227
Salt.....thousand short tons..	972	4,671	1,118	W
Sand and gravel.....do.....	5,068	17,872	³ 4,337	³ 11,006
Stone ⁴do.....	10,583	24,333	9,717	24,133
Value of items that cannot be disclosed:				
Cement, clays (fire clay), lime, natural gas liquids, and values indicated by symbol W	XX	49,226	XX	66,596
Total	XX	3,390,211	XX	3,498,001
Total 1967 constant dollars	XX	1,341,506	XX	^p 1,257,531

^p Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed."

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

² Excludes fire clay; value included with "Value of items that cannot be disclosed."

³ Excludes industrial sand and gravel; value included with "Value of items that cannot be disclosed."

⁴ Excludes dimension stone; value included with "Value of items that cannot be disclosed."

Table 2.—Value of mineral production in West Virginia, by county¹
(Thousands)

County	1975	1976 ²	Minerals produced in 1976 in order of value ³
Barbour	\$81,988	NA	(Coal).
Berkeley	20,185	\$20,181	Cement, stone, clays.
Boone	299,417	NA	(Coal).
Braxton	1,928	4	Stone.
Brooke	W	NA	(Coal).
Cabell	W	W	Clays.
Clay	1,951	NA	(Coal).
Fayette	W	220	Stone, (coal).
Gilmer	2,894	57	Do.
Grant	W	W	Do.
Greenbrier	W	W	Do.
Hampshire	W	W	Stone.
Hancock	W	W	Sand and gravel, clays.
Harrison	78,112	413	Stone, (coal).
Jefferson	W	W	Stone.
Kanawha	W	W	Natural gas liquids, stone, (coal).
Lewis	W	W	Stone, (coal).
Lincoln	W	W	Clays, (coal).
Logan	W	W	Stone, sand and gravel, (coal).
McDowell	488,939	NA	(Coal).
Marion	W	NA	Do.
Marshall	W	W	Salt, (coal).
Mason	W	W	Sand and gravel, (coal).
Mercer	W	W	Stone, (coal).
Mineral	W	W	Do.
Mingo	123,315	NA	(Coal).
Monongalia	W	W	Stone, (coal).
Monroe	W	4	Stone.
Morgan	W	W	Sand and gravel.
Nicholas	W	W	Stone, (coal).
Ohio	W	NA	(Coal).
Pendleton	W	W	Lime, stone.
Pocahontas	316	350	Stone.
Preston	W	W	Stone, (coal).
Raleigh	W	1,049	Do.
Randolph	22,673	1,851	Do.
Roane	W	186	Stone.
Summers	1,436	NA	(Coal).
Taylor	3,168	NA	Do.
Tucker	W	W	Stone, (coal).
Tyler	W	W	Salt, sand and gravel.
Upshur	49,497	NA	(Coal).
Wayne	W	W	Natural gas liquids, (coal).
Webster	10,996	NA	(Coal).
Wetzel	W	W	Natural gas liquids, sand and gravel.
Wirt	W	65	Stone.
Wood	W	W	Sand and gravel.
Wyoming	W	156	Stone, sand and gravel, (coal).
Undistributed ⁴	2,208,447	3,473,466	
Total ⁵	3,390,211	3,498,001	

NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

¹ Calhoun, Doddridge, Hardy, Jackson, Pleasants, Putnam, and Ritchie Counties are not listed because no production was reported.

² County figures exclude value of bituminous coal, which was not available on a county basis; total is included in "Undistributed."

³ Counties having coal production in 1976 have the word coal inserted parenthetically in the column "Minerals produced in 1976 in order of value;" this placement however should not be taken to indicate the relative ranking of coal on a value basis among the commodities produced in the county.

⁴ Includes natural gas, petroleum, coal, and gem stones that cannot be assigned to specific counties, and values indicated by symbol W.

⁵ Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of West Virginia business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ----- thousands..	649.8	679.0	+4.5
Unemployment ----- do.....	45.5	51.0	+12.1
Employment (nonagricultural):			
Mining ----- do.....	63.9	68.5	+7.2
Manufacturing ----- do.....	121.1	124.0	+2.4
Contract construction ----- do.....	30.5	33.6	+10.2
Transportation and public utilities ----- do.....	39.6	39.2	-1.0
Wholesale and retail trade ----- do.....	113.5	117.1	+3.2
Finance, insurance, real estate ----- do.....	18.4	18.5	+5
Services ----- do.....	79.6	84.1	+5.7
Government ----- do.....	108.1	109.2	+1.0
Total nonagricultural employment ----- do.....	574.7	¹ 594.1	+3.4
Personal income:			
Total ----- millions..	\$8,886	\$9,941	+11.9
Per capita ----- do.....	\$4,927	\$5,460	+10.8
Construction activity:			
Number of private and public residential units authorized ----- do.....	2,072	2,647	+27.8
Value of nonresidential construction ----- millions..	\$64.6	\$65.5	+1.4
Value of State road contract awards ----- do.....	\$261.0	\$250.0	-4.2
Shipments of portland and masonry cement to and within the State ----- thousand short tons..	609	630	+3.4
Mineral production value:			
Total crude mineral value ----- millions..	\$3,390.2	\$3,498.0	+3.2
Value per capita, resident population ----- do.....	\$1,884	\$1,921	+2.0
Value per square mile ----- do.....	\$140,201	\$144,659	+3.2

^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.

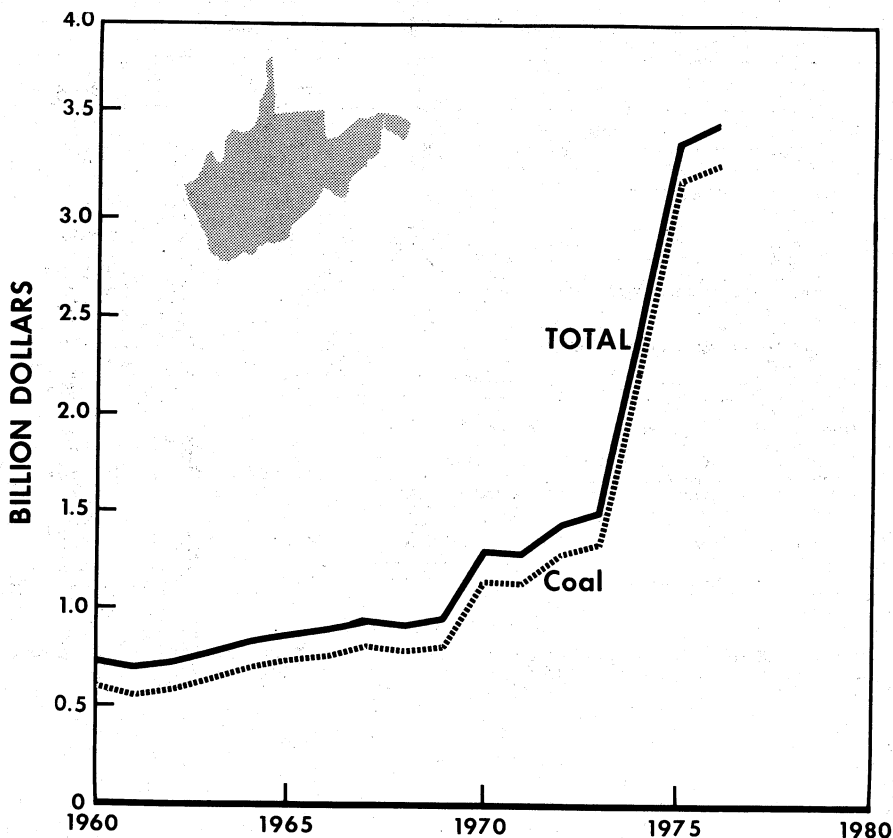


Figure 1.—Value of coal and total value of mineral production in West Virginia.

Trends and Developments.—The mining phase of the longwall strip mining experiment conducted jointly by the West Virginia Surface Mining and Reclamation Association and the Environmental Protection Agency (EPA), which actually became a shortwall experiment, was concluded. The experiment, which was funded by a \$1.35 million grant from EPA and \$650,000 from the surface mine association, was conducted on a site owned by Southern Appalachian Coal Co. near Julian, Boone County.

The American Electric Power System (AEP) planned to ship 200 tons of coal from the new Martinka mine near Fairmont, Marion County, to California as part of a coal-desulfurization research and development project being carried out by TRW, Inc. A pilot plant, being built at San Juan Capistrano, Calif., under spon-

sorship of the EPA, will seek to desulfurize coal chemically by TRW's "Meyers Process." If successful, an alternative to scrubbing would be provided for the control of sulfur-oxide emissions from coal-fired electric powerplants.

Employment.—Preliminary data for 1976 and final indicators of West Virginia business activity are shown in table 3. Employment in the mining sector registered an increase of 7.2%.

Legislation and Government Programs.—The second regular session of the 62d Legislature passed several bills relating to mining and natural resources. These included: S.B. 454 requiring reclamation of land disturbed by deep mine operations, and raising the reclamation bond requirement from \$500 to \$5,000 an acre; Com. Sub. for S.B. 157 relating to requirements

for the reclamation of lands affected by oil and gas drilling, and requiring bond to assure that reclamation is carried out; and Com. Sub. for S.B. 183 requiring a permit from the Department of Natural Resources for any preparation plant. H.B. 1088, passed May 15, 1976, during an extension of the legislative session, imposed an additional business and occupation tax on the severance, extraction, and production of coal, and provided for distribution of revenue from such tax to counties and municipalities.

The National Mine Health and Safety Academy located at Beckley was formally opened in April 1976. The \$20 million dollar facility to train mine inspectors is situated on 40 acres donated by the Raleigh County Airport Authority, and includes classrooms and laboratories for 600 students, dormitory space for 350, a learning resource center, an instructional shop for mining equipment study and repair, an auditorium, and a gymnasium.

West Virginia University received a \$55,000 grant from EPA to continue the university's air pollution control program that was initiated in 1963 and designed to train people to work as air pollution control specialists with regulatory agencies.

A coal research facility will be built by the U.S. Energy Research and Development Administration (ERDA) at West Virginia University. The facility will burn high-sulfur coal in a fluidized bed of crushed limestone. The heart of the new system is three steam boilers (called cells), each containing a bed of crushed limestone suspended in a compressed airstream. When coal is burned in the bed, the sulfur in the coal combines with calcium in the limestone to form calcium sulfate rather than with oxygen in the air to form sulfur dioxide.

The West Virginia Geological and Economic Survey was awarded a \$660,364 contract by ERDA to carry out the first year of

a long-range, comprehensive research project on Devonian shales. The study is designed to arrive at an accurate appraisal of the energy-resource base of the Devonian shales in West Virginia.

ERDA extended its research grant to the State Survey to study the Waynesburg coal. Under the new funding, the study will be extended to a three-dimensional model, and from the more local within-a-mine study to a more regional investigation. The original study dealt almost exclusively with the inorganic components of the coal. The coal will be described petrographically so that statistical procedures can test correlations between the organic and inorganic portions. The organic portion will be further described with selected coals being subjected to proximate and ultimate analysis.

As part of a nationwide study being funded by Argonne National Laboratories, the West Virginia Geological and Economic Survey received a grant for a comprehensive study of the potential environmental impact of surface mining. The objective is to pinpoint potential environmental problems before mining so that adequate treatment can be designed into a mining operation during the premining design stage.

Aeromagnetic coverage of West Virginia, carried out under a cooperative program between the West Virginia Geological and Economic Survey and the U.S. Geological Survey (USGS), was completed with the release of an aeromagnetic map of northern West Virginia; maps of the central and southern parts of the State had previously been released. The cooperative groundwater investigations with the USGS that began in 1941 continued, resulting in the completion of the fifth and sixth river-basin studies (water resources of the Coal and Elk River basins) and the initiation of the seventh basin study in this series (water resources of the Guyandotte River basin).

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Carbon Black.—Two furnace process plants, one south of Moundsville, Marshall County, and the other north of Waverly, Pleasants County, produced carbon black in

1976. Production increased more than 7% in quantity and 22% in value over the 1975 level.

Coal (Bituminous).—Production of bituminous coal in West Virginia in 1976 amounted to 108,834,000 short tons, com-

pared with 109,283,000 short tons in 1975. The total value of this production increased slightly over that of the previous year.

Three counties produced more than 10 million tons each. These were, in descending order, Monongalia, McDowell, and Boone. Monongalia has been the leading county for the past 3 years, surpassing McDowell in 1974. Eight additional counties produced more than 5 million tons each; these were, in order of tonnage, Logan, Wyoming, Kanawha, Raleigh, Marion, Harrison, Nicholas, and Marshall.

Underground production of coal in West Virginia amounted to 87,559,000 tons, with an average value per ton of \$31.64. Surface mine production was 21,275,000 tons having an average value per ton of \$23.86.

The number of coal-cleaning plants operated in the State during 1976 totaled 135, 11 more than in 1975. These plants cleaned 94.7 million tons of raw coal to produce 64.4 million tons of cleaned product and 30.3 million tons of refuse. A total of 49 thermal dryers was used at 36 coal-cleaning plants to dry 22.6% of the cleaned coal production.

Of the total coal production in 1976, 84.9 million tons was shipped by railroads, compared with 79.4 million tons in 1975. Unit trains carried 25.0 million tons, compared with 26.0 million tons in the previous year. Coal shipped by waterways totaled 11.5 million tons, compared with 14.9 million tons in 1975. The balance of the total production was transported either by truck or conveyors for use near or at mine mouth.

Table 4.—West Virginia: Bituminous coal production

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1972	123,743	1,275,813
1973	115,448	1,340,338
1974	102,462	2,218,418
1975	109,283	3,206,951
1976	108,834	3,278,180

Coke and Coal Chemicals.—Coke produced at three oven-coke plants totaled 3.5 million tons in 1976. Coal carbonized at these coke plants amounted to 5.2 million tons. The coke yield was 66.8%, slightly lower than the 1975 yield of 67.1%. The

average value per ton of coal used at West Virginia coking plants in 1976 was \$43.93, compared with \$40.59 in 1975. A total of 5.3 million tons of coal was received by these plants in 1976 with 2.8 million tons from Pennsylvania, 1.9 million tons from West Virginia, and the balance of 0.6 million tons from Kentucky, Virginia, and Arkansas.

Coal-chemical materials produced at these oven-coke plants included tar, gas, ammonium sulfate, and crude light oil. Coke-oven tar production amounted to 39.3 million gallons; coke-oven gas totaled 59.6 million cubic feet; ammonium sulfate production was 27,000 tons; and coke-oven crude light oil was 14.4 million gallons.

Natural Gas Liquids.—Natural gas liquids continued to be produced by Columbia Gas Transmission Corp. at its Cobb plant, Kanawha County, and Kenova plant, Wayne County, and by Consolidated Gas Supply Corp. at its Hastings plant, Wetzel County. Compared with 1975, production decreased in quantity but remained about the same in value.

Petroleum and Natural Gas.—Crude oil production in 1976 was 2,519,000 barrels valued at \$30,227,000, a 1.6% increase in output over that of 1975. Natural gas production decreased slightly from 154,484 million cubic feet in 1975 to 153,322 million cubic feet in 1976 but rose in value from \$57.0 million to \$87.4 million.

The Oil and Gas Div. of the West Virginia Department of Mines issued 1,173 permits to drill new wells or deepen old wells during 1976. Over one-third of these were issued to drill "Big Injun" wells, especially in Gilmer, Ritchie, Clay, Doddridge, and Braxton Counties. Almost another third were issued to drill to Catskill and Chemung targets in the Benson trend in the north-central part of the State.

The total number of wells completed, including 46 work overs, was 1,027. Of these, 722 were gas wells, 81 were oil wells, 87 were combination wells, 50 were miscellaneous (46 injection wells, 2 storage wells, 1 salt well, and 1 stratigraphic test), and 87 were dry wells. The Glenville field in Gilmer County was the most active gas-field and the Griffithsville field in Lincoln County was the most active oilfield.

Completed exploratory wells numbered 112. This included 24 new field wildcats, of which 13 were successful; 21 new pool

tests, 12 of which were discoveries; 32 deeper pool tests, with 17 deeper pool discoveries; and 35 outpost wells.

Columbia Gas Transmission Corp. continued to expand their enhanced-recovery project in the Granny Creek-Stockly field of Clay County. ERDA also continued to expand its efforts in secondary recovery activities. Under an ERDA contract, Guyan Oil Co. completed drilling a 25-well pilot program in the Griffithsville field of Lincoln County, for enhanced recovery utilizing carbon dioxide. ERDA completed a core analysis of the basal dolomite facies of the Big Lime in the Hilly Upland oil area, Weston-Jane Lew field of Lewis County. Pennzoil's carbon dioxide injection in the Big Injun in Walton (Rock Creek) field, Roane County, also was ERDA-sponsored. Three pilot waterfloods operated in Boggs, Granny Creek-Stockly, and Rock Creek fields, although the last two may be replaced by expansion of carbon dioxide projects.

West Virginia has 25 gas storage fields with reservoir sandstones ranging in age from Early Mississippian to Early Devonian. A total of 372,967 million cubic feet of gas was stored in these fields at the beginning of 1976, ranking West Virginia sixth in the United States in storage gas.

According to the American Petroleum Institute, estimated proved reserves of crude oil in West Virginia totaled 30.0 million barrels on December 31, 1976, compared with 31.4 million barrels on December 31, 1975. Estimated proved reserves of natural gas in the State, according to the American Gas Association, were 2,273 billion cubic feet on December 31, 1976, compared with 2,311 billion cubic feet on December 31, 1975.

NONMETALS

Cement.—Production of portland cement declined 2.5% below the 1975 level while shipments and the total value of those shipments increased 0.04% and 1.0% respectively. The average value per ton also increased above the 1975 level by about 1%. Stocks on hand at the end of the year declined by 34.6% in comparison with that on hand at the end of 1975.

Trucks transported 80.4% of the 1976 portland cement shipments while railroads carried the balance of 19.6%. The pattern

of distribution of these shipments was 62.4% to ready-mix concrete companies, 25.5% to concrete product manufacturers, 6.3% to building material dealers, 1.4% to highway contractors, and 4.4% to unspecified contractors and government agencies.

Masonry cement production increased 34.0% during the year while the amount sold increased 27.1% over 1975. The total value of shipments during 1976 increased 31.4% with the average value per ton increasing by 3.4%. Stocks on hand at the end of the year were 138.4% above the level on hand at the end of 1975.

Both portland and masonry cement were produced at three coal-fired kilns located near Martinsburg in Berkeley County. All three kiln units are equipped with electrostatic precipitators to reduce airborne particulates.

Clays.—Clays were produced in four counties—Berkeley, Cabell, Hancock, and Lincoln—in 1976. Berkeley County was the leading producer of miscellaneous clay, and Hancock County was the sole producer of fire clay. The quantity and value of total clays output increased over that of the previous year. Miscellaneous clay production was slightly less than in the previous year, and the value of this production was up 5.5%. Production of fire clay increased 30.8% and the total value increased 45.6%. Six companies mined clays for production of common unprocessed brick, unprocessed face brick, fire brick, cement block, and mine explosives stemming.

Lime.—Total production declined 7.9% below the 1975 level while the total value of this production decreased 5.3%. The average value per short ton, however, increased 2.8%. Production of quicklime declined 28.5% while the value of this type of lime produced during the year decreased 23.8%. One company operated a plant in Pendleton County. An increase of 6.6% occurred in the average unit value of quicklime. On the other hand, production of hydrated lime increased 57.5% while the total value of this type of lime increased 48.6%. The average value per short ton of hydrated lime declined 5.7%.

Salt.—Production increased 15%, or 146,000 tons, above the 1975 level to 1,118,000 tons. The estimated total value of this production also increased. Three companies pumped brine from deep well solution mining operations in Marshall and

Tyler Counties. Soda ash, chlorine, hydrochloric acid, bleaching powder, calcium, magnesium chlorides, and bromine were produced from the brine.

Sand and Gravel.—Output of sand and gravel in 1976, excluding industrial sand and gravel, amounted to 4,337,000 short tons valued at \$11,006,000. Eight companies with 10 operations produced in 8 counties during the year. In descending order of production, Hancock, Morgan, and Wetzel Counties were the leading producers.

Table 5.—West Virginia: Sand and gravel sold or used by producer

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:			
Sand -----	2,056	\$5,062	\$2.46
Gravel -----	2,280	5,943	2.61
Industrial sand -	W	W	W
Total ¹ ----	4,337	11,066	2.54

W Withheld to avoid disclosing company proprietary data; not included in "Total."

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

Stone.—Crushed stone production decreased 8% to 9,717,000 short tons while the value of this output declined 0.8% to \$24.1 million. The average value per ton increased 8%, or \$0.18 per ton, above the 1975 level. Crushed limestone production declined 11.6% while crushed sandstone production increased 59.2%.

Crushed stone was produced by 43 companies at 52 mines and quarries in 26 counties for roadstone, roadbase aggregate, concrete, and other uses. The leading producers of crushed stone were Greer Limestone Co., Acme Limestone Co., and United States

Table 6.—West Virginia: Construction sand and gravel sold or used, by major use category

Use	1976		
	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (residential, non-residential, highways, bridges, dams, waterworks, airports, etc.) -----	2,391	\$5,407	\$2.26
Concrete products (cement blocks, bricks, pipe, etc.) -	1,121	3,522	3.14
Asphaltic concrete aggregates and other bituminous mixtures -----	501	1,049	2.09
Roadbase and coverings -----	91	47	.52
Fill -----	108	231	2.14
Other uses -----	124	749	6.04
Total ¹ -----	4,337	11,006	2.54

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

Steel Corp. Howard W. Fields Co. quarried dimension sandstone in Greenbrier County for rough flagging.

Crushed limestone was produced in 16 counties by 29 companies that operated 35 mines and quarries. The four counties that led in production, in descending order of output, were Monongalia, Greenbrier, Jefferson, and Berkeley. Major uses were construction aggregate, cement, chemicals, lime, metallurgical flux, railroad ballast, mine dust, and agriculture.

Crushed sandstone was produced in 12 counties by 14 companies that operated 17 quarries. The four counties that led in production, in descending order of production, were Raleigh, Fayette, Kanawha, and Wyoming. Major uses were in construction and glass manufacturing.

Table 7.—West Virginia: Crushed stone sold or used by producers, by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Bituminous aggregate -----	258	821	297	819
Concrete aggregate -----	1,806	3,232	1,172	2,670
Dense-graded roadbase stone -----	1,303	3,739	1,636	4,653
Macadam aggregate -----	81	278	17	46
Other construction aggregate and roadstone -----	3,088	7,536	2,722	7,257
Surface treatment aggregate -----	538	1,140	542	1,163
Agricultural purposes ¹ -----	113	352	157	475
Cement and lime manufacture -----	1,386	2,332	1,439	2,412
Mine dusting -----	166	1,127	168	1,266
Railroad ballast -----	646	1,062	574	951
Riprap and jetty stone -----	31	94	29	96
Other uses ² -----	1,167	2,619	964	2,340
Total ³ -----	10,583	24,333	9,717	24,133

¹ Includes agricultural limestone and other soil conditioners.

² Includes fill (1975), filter stone, manufactured fine aggregate, flux stone, refractory stone, disinfectant, and fill (1976).

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

METALS

Aluminum.—During 1976, primary aluminum production decreased 14.1% below the 1975 level. The total value of this production during the year declined only 1.8%. This disparity is explained by a 15% increase in the average value per pound above the 1975 average value. The only completely integrated aluminum plant in the State is operated by Kaiser Aluminum & Chemical Corp. at Ravenswood, Jackson County. Following electrolytic conversion of imported alumina, aluminum ingots are rolled into sheet, plate, and foil. These rolled products are shipped to companies that manufacture finished aluminum products.

Ferroalloys.—The total production of all types of ferroalloys was 169,420 tons, an increase of 12% over the output in 1975. Total value of this production was \$81.9 million compared with the 1975 value of \$78.6 million.

Three companies produced ferroalloys: Union Carbide Corp. at its Alloy plant, Fayette County; Foote Mineral Co. at its Graham plant, Mason County; and Diamond Shamrock Corp. at its Kingwood plant, Preston County.

Iron and Steel.—Both production and shipments of pig iron increased about 18.6% in 1976, compared with the previous year. Stocks on hand at yearend were 79.7% above the 1975 yearend level. Total value of shipments increased 19.7%, but the aver-

age value per short ton remained about the same as in 1975.

National Steel Corp.'s Weirton Steel Co. Div. completed an air-cleaning system for its boiler house and a two-phase air-cleaning program for the sinter plant. Equipment to recycle 40% of the emissions generated by sinter production was installed; the remaining emissions are treated in a gravel-bed filter system. The boiler and sinter plants had been among the more difficult pollution sources to control. Regenerator iron oxide for pigment and magnetic uses was produced from the pickling liquor treatment plant installed to control water-polluting effluents.

Nickel.—Huntington Alloy Products Div. of the International Nickel Co. produced nickel and various types of high-nickel alloys at its Huntington plant in Cabell County. Principal products included mill forms, such as sheet, strip, plate, pipe, tube, wire, rod, bar, and welding products, such as nickel and high-nickel bare welding filler wire, coated electrodes, and welding fluxes.

Zinc.—The zinc plant at Spelter, Harrison County, operated by Meadowbrook Corp., a wholly owned subsidiary of TL Diamond and Co., Inc., produced zinc dust and slab zinc in 1976. Raw materials used included zinc dross, zinc ash, and other zinc residues.

Zirconium and Hafnium.—The Parkersburg, Wood County, metal plant of AMAX Specialty Metals Corp. which terminated

operations in 1975, remained closed in 1976, but supplied zirconium and hafnium from inventory to the company's Akron, N.Y., plant. The Buckhannon plant of Corhart

Refractories Co. in Upshur County produced high-density zircon and chromic oxide refractory bricks.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Carbon black:			
Cabot Corp -----	125 High St. Boston, Mass. 02110	Furnace -----	Pleasants.
Cities Service Co -----	Box 300 Tulsa, Okla. 74102	----do -----	Marshall.
Cement: Martin-Marietta Corp. ¹	277 Park Ave. New York, N.Y. 10017	Plant -----	Berkeley.
Clays:			
Crescent Brick Co., Inc --	Box 368 New Cumberland, W. Va. 26047	Underground mine.	Hancock.
Globe Refractories, Inc --	Box D Newell, W. Va. 26060	----do -----	Do.
Coal:			
Amherst Coal Co -----	Port Amherst Charleston, W. Va. 25306	Underground and strip mines.	Logan and Wyoming.
Armco Steel Co -----	703 Curtis St. Middletown, Ohio 45042	Underground mines.	Boone and Raleigh.
Bethlehem Mines Corp --	Martin Tower Bethlehem, Pa. 18016	Underground and strip mines.	Barbour, Boone, Kanawha, Marion, Nicholas, Raleigh.
Consolidation Coal Co ---	1 Oliver Plaza Pittsburgh, Pa. 15219	Underground, strip, and auger mines.	Harrison, Marion, Marshall, Mercer, Monongalia, McDowell, Raleigh, Wyoming.
Eastern Associated Coal Corp.	Koppers Bldg. Pittsburgh, Pa. 15219	Underground and strip mines.	Boone, Marion, McDowell, Monongalia, Raleigh, Wyoming.
Island Creek Coal Co ----	2355 Harrodsburg Rd. Lexington, Ky. 40511	----do -----	Boone, Grant, Logan, Nicholas, Upshur, Wyoming.
United States Steel Corp. ²	600 Grant St. Pittsburgh, Pa. 15230	----do -----	McDowell, Mingo, Wyoming.
Valley Camp Coal Co ----	700 Westgate Tower Cleveland, Ohio 44116	----do -----	Kanawha, Marshall, Ohio.
Westmoreland Coal Co --	123 South Broad St. Philadelphia, Pa. 19109	----do -----	Boone, Fayette, Greenbrier, Nicholas, Raleigh, Wyoming.
Lime:			
Germany Valley Limestone Co.	Box 302 Riverton, W. Va. 26814	Plant -----	Pendleton.
Natural gas liquids:			
Columbia Gas Transmission Corp.	1700 MacCorkle Ave., SE. Charleston, W. Va. 25314	Plants -----	Kanawha and Wayne.
Consolidated Gas Supply Corp.	445 West Main St. Clarksburg, W. Va. 26301	Plant -----	Wetzel.
Petroleum refineries:			
Pennzoil Co -----	Oil City, Pa. 16301	----do -----	Kanawha.
Quaker State Oil Refining Corp.	Farmers Valley, Pa. 16749	Plants -----	Hancock and Pleasants.
Salt:			
Allied Chemical Corp ----	Box 1219R Morristown, N.J. 07960	Plant -----	Marshall.
FMC Corp -----	Box 8127 South Charleston, W. Va. 25303	Plants -----	Tyler.
PPG Industries, Inc ----	1 Gateway Center Pittsburgh, Pa. 15222	Plant -----	Marshall.
Sand and gravel:			
Dravo Corp -----	1 Oliver Plaza Pittsburgh, Pa. 15222	Dredge -----	Hancock.
McDonough Co -----	Box 538 Parkersburg, W. Va. 26100	----do -----	Tyler and Wetzel.
Pennsylvania Glass Sand Corp.	Berkeley Springs, W. Va. 25411	Plant -----	Morgan.

See footnotes at end of table.

Table 8.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Shippingport Sand and Gravel Co.	1200 Stambough Bldg. Youngstown, Ohio 44501	Plant -----	Hancock.
Smelters: Kaiser Aluminum & Chemical Corp.	300 Lakeside Dr. Oakland, Calif. 94626	-----do -----	Jackson.
Stone:			
Acme Limestone Co -----	Box 27 Fort Spring, W. Va. 24936	Mine and quarry-	Greenbrier.
Black Rock Contracting, Inc.	Box 1918 Charleston, W. Va. 25327	Quarry -----	Randolph.
Elkins Limestone Co ----	Box 1228 Elkins, W. Va. 26241	Mine and quarry-	Do.
The H. Frazier Co., Inc --	Box 1377 Richmond, Va. 23211	Quarry -----	Greenbrier.
Shenandoah Quarry, Inc --	Box C Millville, W. Va. 25432	-----do -----	Jefferson.

¹ Also clays.² Also stone.

The Mineral Industry of Wisconsin

This chapter has been prepared by the Bureau of Mines, U.S. Department of the Interior, and the Geological and Natural History Survey of Wisconsin, under a memorandum of understanding for collecting information on all minerals except coal and liquid fuels.

By Ronald C. Briggs¹ and Meredith E. Ostrom²

While fluctuations were noted for individual mineral commodities, overall output from Wisconsin operations remained essentially the same as that for the previous year. Total value of the mineral products inched slightly higher to a new record of \$132.5 million. Decreases in the production of portland cement and iron ore offset the modest gains in other materials.

Nonmetallic minerals accounted for nearly 80% of the total mineral value during 1976. Construction aggregates, including both sand and gravel and crushed and broken stone, accounted for nearly all of

the nonmetallic tonnage and about 75% of the total value for nonmetals. Production of stone remained about the same as in 1975, while the production of sand and gravel increased about 3%. Dimension stone unit prices increased, raising the total stone value by nearly 3%. Sand and gravel value increases were nearly commensurate with the tonnage increases. Cement declined significantly in both tonnage and

¹ State Liaison Officer, Bureau of Mines, Twin Cities, Minn.

² Director and State Geologist, Geological and Natural History Survey of Wisconsin, Madison, Wis.

Table 1.—Mineral production in Wisconsin¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons--	2	\$4	W	W
Gem stones -----	NA	1	NA	\$1
Iron ore (usable)				
----- thousand long tons, gross weight--	791	W	664	W
Lime ----- thousand short tons--	296	8,604	325	10,058
Peat ----- do-----	11	502	11	W
Sand and gravel ----- do-----	30,057	40,580	30,879	42,001
Stone ----- do-----	20,566	40,156	20,789	41,888
Value of items that cannot be disclosed:				
Abrasive stone, cement, copper (1975), lead, silver (1976), zinc, and values indicated by symbol W -----	XX	42,413	XX	39,055
Total -----	XX	132,260	XX	132,453
Total 1967 constant dollars -----	XX	52,385	XX	p 47,617

p Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Value of items that cannot be disclosed." XX Not applicable.

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

Table 2.—Value of mineral production in Wisconsin, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Adams	\$2	\$29	Sand and gravel.
Ashland	W	43	Do.
Barron	384	1,048	Do.
Bayfield	35	W	Do.
Brown	W	W	Lime, stone, sand and gravel.
Buffalo	628	789	Stone, sand and gravel.
Burnett	117	331	Sand and gravel, stone.
Calumet	W	W	Stone, sand and gravel.
Chippewa	405	496	Sand and gravel.
Clark	1,237	1,538	Do.
Columbia	4,323	W	Sand and gravel, stone.
Crawford	W	837	Stone, sand and gravel.
Dane	W	W	Sand and gravel, stone.
Dodge	W	W	Lime, stone, sand and gravel.
Door	751	574	Sand and gravel, stone.
Douglas	12,168	13,151	Cement, lime, sand and gravel, stone.
Dunn	432	595	Stone, sand and gravel.
Eau Claire	805	W	Sand and gravel.
Florence	24	29	Do.
Fond du Lac	W	2,134	Stone, sand and gravel, lime, clays.
Forest	77	W	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Green	949	W	Do.
Green Lake	1,586	1,938	Sand and gravel, stone.
Iowa	W	693	Stone.
Iron	69	111	Sand and gravel.
Jackson	W	W	Iron ore, sand and gravel.
Jefferson	598	432	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	764	1,526	Sand and gravel.
Kewaunee	398	444	Do.
La Crosse	1,205	W	Stone, sand and gravel.
Lafayette	W	W	Zinc, stone, lead.
Langlade	W	W	Sand and gravel.
Lincoln	606	601	Do.
Manitowoc	3,800	4,704	Cement, lime, sand and gravel, stone.
Marathon	5,478	5,368	Stone, sand and gravel.
Marquette	2,177	2,430	Do.
Marquette	W	W	Do.
Menominee	W	W	Sand and gravel.
Milwaukee	W	W	Cement, stone.
Monroe	603	239	Stone.
Oconto	W	W	Sand and gravel, stone.
Oneida	574	698	Sand and gravel.
Outagamie	W	W	Stone, sand and gravel.
Ozaukee	W	W	Sand and gravel, stone.
Pepin	W	W	Stone, sand and gravel.
Pierce	W	W	Do.
Folk	W	2,401	Do.
Portage	770	765	Sand and gravel.
Price	W	32	Do.
Racine	3,445	2,605	Stone, sand and gravel.
Richland	W	W	Do.
Rock	2,358	3,120	Sand and gravel, stone.
Rusk	607	462	Sand and gravel.
St. Croix	627	1,000	Stone, sand and gravel.
Sauk	W	W	Stone, sand and gravel, abrasive stone.
Sawyer	573	232	Sand and gravel.
Shawano	642	W	Sand and gravel, stone.
Sheboygan	670	W	Do.
Taylor	555	961	Sand and gravel.
Trempealeau	W	W	Stone.
Vernon	W	W	Stone, sand and gravel.
Vilas	277	389	Sand and gravel.
Walworth	1,337	921	Sand and gravel, stone.
Washburn	71	W	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Waukesha	9,662	W	Stone, sand and gravel, peat.
Waupaca	599	726	Sand and gravel, stone.
Waushara	524	426	Sand and gravel.
Winnebago	3,452	3,484	Stone, sand and gravel.
Wood	W	W	Do.
Undistributed ¹	65,343	74,149	
Total ²	132,260	132,453	

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

¹ Includes gem stones which 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 Wisconsin business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands---	2,128.0	2,175.0	+2.2
Unemployment -----do-----	148.0	122.0	-17.6
Employment (nonagricultural):			
Mining -----do-----	2.7	2.5	-7.4
Manufacturing -----do-----	507.0	512.3	+1.0
Contract construction -----do-----	60.6	65.6	+8.3
Transportation and public utilities -----do-----	81.7	82.2	+6
Wholesale and retail trade -----do-----	374.7	389.5	+3.9
Finance, insurance, real estate -----do-----	74.5	77.2	+3.6
Services -----do-----	290.2	306.4	+5.6
Government -----do-----	285.4	288.6	+1.1
Total nonagricultural employment-----do-----	1,676.8	1,724.4	+2.8
Personal income:			
Total -----millions---	\$25,640	\$28,190	+9.9
Per capita -----do-----	\$5,588	\$6,117	+9.5
Construction activity:			
Number of private and public residential units authorized-----	26,002	35,263	+35.6
Value of nonresidential construction -----millions---	\$284.4	\$394.7	+38.8
Value of State road contract awards -----do-----	\$31.4	\$30.0	-4.5
Shipments of portland and masonry cement to and within the State -----thousand short tons---	1,605	1,669	+4.0
Mineral production value:			
Total crude mineral value -----millions---	\$132.3	\$132.5	+2
Value per capita, resident population -----do-----	\$29	\$29	--
Value per square mile -----do-----	\$2,355	\$2,359	+2

^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.

value with the closing of a cement plant in 1975. The plant closing reduced the number of cement producers in the State to three during 1976. The quantitative output of other nonmetallic minerals, including abrasive stone and lime, showed a small increase over that of 1975.

Iron ore continued as the single most important metallic element mined in the State. For the third consecutive year, shipments from the Jackson County Iron Co. declined. Zinc, with a small amount of byproduct lead, were the only other metallic minerals produced in the State. Eagle-Picher Industries, Inc., operated two mines in the Upper Mississippi Valley zinc-lead district. While no copper was actually mined, a great deal of exploration activity was underway in the State during 1976. A 55-acre open pit mine proposed by Flambeau Mining Corp., a wholly owned subsidiary of Kennecott Copper Corporation, was the subject of an Environmental Impact Statement (EIS) prepared by the Wisconsin Department of Natural Resources (DNR). Flambeau requested permits needed to develop a copper mine near Ladysmith. The

firm's plans were temporarily halted when the Rusk County Board voted to withhold action on any mining company request for zoning changes or permits.

Further highlighting Wisconsin's mineral-related events was the announcement in May by Exxon Co. U.S.A. of the discovery of a major zinc-copper deposit in northern Wisconsin. The mineral find was estimated at about 60 million tons averaging 6.5% zinc and 1% copper with lesser amounts of silver, gold, and lead. Exxon was but one of several companies actively exploring for base metals in the State.

Eagle-Picher Industries, Inc., made application and received permits to begin reopening two zinc mines in southwestern Wisconsin. The company planned to have the Elmo mine in Grant County and the Crawhall mine in Lafayette County in production in mid-1977. Production from these mines was expected to provide an additional 1,400 tons of ore daily to the company's operation.

Dedication ceremonies held in Superior on June 17, 1976, concluded several years

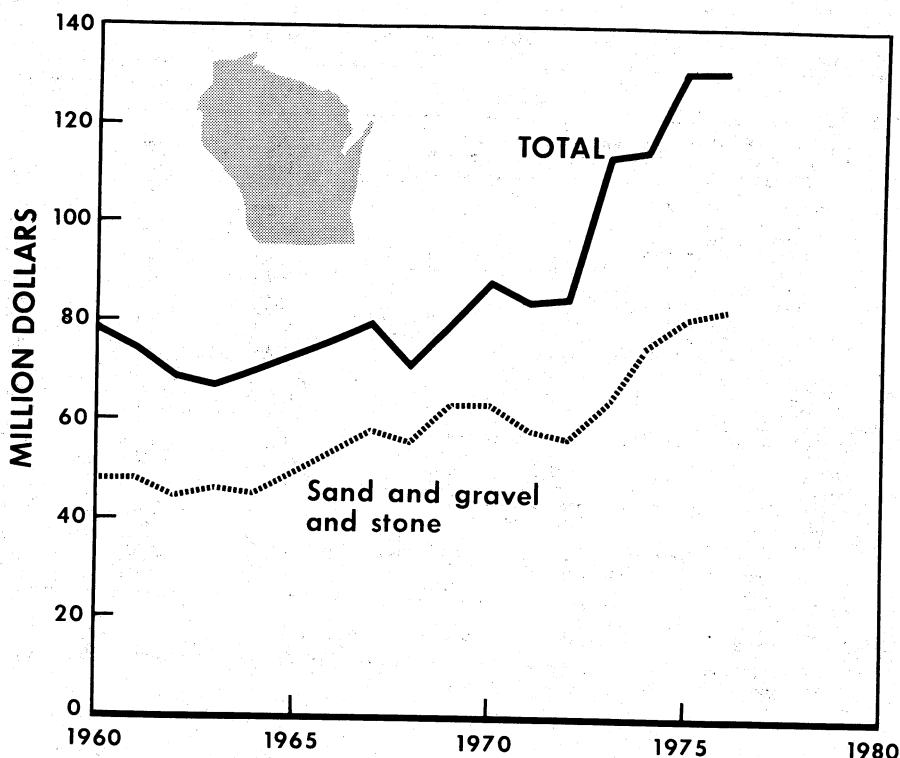


Figure 1.—Value of sand and gravel, stone, and total value of mineral production in Wisconsin.

of planning and over 2½ years of construction on the new \$40 million Superior Midwest Energy Terminal. This coal transshipment terminal is owned by Midwest Energy Resources, Inc., a wholly owned subsidiary of Detroit-Edison Co. It was designed and will be operated by the Orba Corp. of Fairfield, N.J., a leader in the design of such bulk shipment facilities, and the C. Reiss Coal Co., Sheboygan, under the corporate name of ORTRAN, Inc. The terminal was designed specifically for transshipment of low-sulfur coal mined in Montana to the St. Clair powerplant operated by Detroit-Edison in Michigan. The new era is unique because it represents a turnaround of former traditional coal movement through the twin ports. In earlier years, coal terminals on Superior's waterfront received eastern coal and shipped it to western con-

sumers, but now the coal arrives in unit trains from Montana mines and is shipped down the Great Lakes to eastern users. The first western coal arrived at the terminal in March, and by the end of the year about 2 million tons of coal had been shipped downlake.

Burlington-Northern, Inc., is also constructing a transshipment terminal on Alouez Bay near Superior. The new storage and shiploading facility for iron ore pellets will require a capital expenditure totaling \$70 million. By yearend, the terminal was about 90% complete. The transshipment terminal includes a taconite pellet stockpile area, conveyors and transfer buildings, and a dockside shiploader. Major considerations for environmental control have been incorporated into all structures.

During 1976, Wisconsin shipyards added to the carrying capacities of the U.S. Great Lakes fleet by completing work on enlarging existing carriers and constructing new vessels. One of the new vessels constructed during the year was the 770-foot *St. Clair*, which was especially designed for the transport of western U.S. low-sulfur coal from Superior to Detroit-Edison Co. powerplants. The *St. Clair*, which holds the record for being the largest vessel ever side-launched on the Great Lakes, has a capacity of 43,500 tons of coal and a self-unloading capability of 7,000 tons per hour. The American Steamship Co.'s newest vessel was christened in the spring and while awaiting the opening of the new transshipment terminal at Superior, the laker transported cargoes between other lake ports. On its maiden voyage, 39,803 gross tons of iron ore pellets were loaded at a Michigan port. The second vessel placed into service during 1976 was the *Joseph L. Bloch*, owned by Inland Steel Co. The 728-foot self-unloader has an ore cargo capacity of about 31,000 long tons. Both new vessels were products of the Bay Shipbuilding Corp. in Sturgeon Bay.

United States Steel Corp. awarded a contract to build a 1,000-foot lake vessel to Bay Shipbuilding Corp. This supercarrier will be the third 1,000-foot vessel in the Great Lakes iron ore trade. Currently the largest vessel in United States Steel's Great Lakes fleet is the 858-foot *Roger Blough*, with a capacity of more than 46,000 tons of pellets. The firm also operated a 1,000-foot tug-barge, the *Presque Isle*, leased from Litton Industries. Present plans call for the new 1,000-foot carrier to be 105 feet wide and capable of carrying in excess of 58,000 long tons of pellets. It will have a discharging rate of 10,000 long tons per hour. Under its contract with Bay Shipbuilding Corp., United States Steel has the option of changing the length specification of the new vessel to 1,100 feet if ships of that size are approved for transportation on the Great Lakes.

Vessels lengthened during the year at the Fraser Shipyards in Superior included the *John G. Munson*, owned by United States Steel, which was enlarged from 666 to 768 feet, and the *Edward B. Greene*, owned by Cleveland-Cliffs Iron Co., which was enlarged from 647 to 767 feet. The *Edward B. Greene* was the 11th Great Lakes ore car-

rier to be lengthened by the Superior shipyard in the past 5 years. A total of 1,182 feet of ship midbodies have been added to the 11 ships, increasing carrying capacity by a total of 55,000 tons per trip.

The E. I. du Pont de Nemours & Co. closed its explosives plant near Barkdale on Chequamagon Bay, a few miles northwest of Ashland. The facility produced small quantities of proprietary explosives used by Du Pont at a Dunbar, Pa., plant to bond dissimilar metals by use of explosive force. The Barkdale plant was one of Du Pont's major dynamite manufacturing facilities from 1905 to 1961. It was established to supply explosives for the Michigan and Minnesota mining and logging industries. It was also the site of the Nation's first TNT production facility, which started in 1912. In addition to TNT, other products produced at the plant included Nitramix and Nitramon blasting agents used in the mining industries. A peak employment of about 6,000 was reached at the plant during World War I, but only 7 persons were employed at the time the plant was closed.

Legislation and Government Programs.—Metal mines in Wisconsin have been taxed piecemeal through different combinations of State and local taxes. To assure that all metal mines are taxed on the same basis, a series of bills that would alter the method the State uses to regulate and tax metallic mineral producers was introduced into the Wisconsin Assembly. The bills were largely based on the recommendations of a special study committee on mineral taxation established about 2 years ago by the legislature. Legislation introduced as a result of the Committee's effort included:

AB 1364—Metallic Minerals: Taxation.—This bill would impose a progressive net proceeds tax on persons engaged in mining metalliferous minerals, including taconite, copper, lead, zinc, silver, and gold. The tax would be assessed on the average of the net proceeds for the 3 years preceding the tax year. Companies with net proceeds of less than \$100,000 would be exempt. Taxation rates would then be progressive beginning with 5% on amounts from \$101,000 to \$500,000; 10% on amounts from \$501,000 to \$2,000,000; 15% on amounts from \$2,000,001 to \$6,000,000; and 20% on amounts exceeding \$6,000,000. Half of the revenues generated would go to the State general

fund, 25% to the municipal- and county-shared tax account, and 25% to an investment and local impact fund. An investment and local impact fund board would be created in the Department of Revenue to manage the investment and distribution of the local impact fund.

AB 1365—Metal Mines: Depletion Allowance.—This bill would phase out the present depletion allowances for metal mines by a prorata amount over the next 4 years. It would repeal in 1976 the depletion allowance for metal mines having a yearly gross income of less than \$100,000 and totally repeal in 1981 the depletion allowance for metal mines under the corporate income tax.

AB 1366—Mineral Exploration: Leases.—The terms of leases of land for metalliferous mineral exploration would be limited to a period of 10 years. The bill would also grant the lessee the option to renew the lease for an additional 10 years.

AB 1367—Mineral Exploration: Leases.—This proposed legislation would give private lessors the right to cancel an exploration lease within 10 days following the date the lease was signed. Public bodies acting as lessors would have 90 calendar days following the signing to cancel exploration leases.

AB 1368—Mineral Exploration: Registration.—This bill would require all parties planning mineral exploration to register with the State Geologist prior to commencing exploration and to define the areas to be explored and the terms of the exploration lease. It would also require that reports be filed with the State Geologist following termination of exploration activity or expiration of any lease.

None of the five bills was passed during the legislative session. However, the announcement of the discovery of a major zinc-copper deposit in northern Wisconsin by Exxon revitalized efforts to revise the State's mining tax laws. The Wisconsin Senate established a special Select Committee on Mining Development to undertake a study of the implications of a potential mining boom in Wisconsin. The Senate committee began meeting jointly with the Assembly's special Study Committee on Mineral Taxation to reconsider a comprehensive mining tax bill.

Potential mineral development in northern Wisconsin, and the various proposals

to revise the State's mineral taxes, generated a great deal of controversy. One of the most controversial aspects of the mineral tax revision was the amount of tax dollars that should be returned to the local areas where the minerals were extracted. Representatives from nine northern counties formed an association to solidify a common approach to the mining issues. By the end of the year, the joint committees presented a revised version of the comprehensive metal mining tax bill. The revised bill was still a net proceeds tax but was modified to be more acceptable to the mining companies and the local government officials in northern Wisconsin.

A 1974 State law requiring registration of severed mineral rights was declared unconstitutional by a northern Wisconsin judge. The circuit court judge ruled that the law violated due process and equal protection clauses of the U.S. Constitution. Additionally, the law was ruled in violation of a provision of the Wisconsin Constitution requiring uniformity of taxation. The law required holders of severed mineral rights to register their claims with a county register of deeds and to pay a 15-cent-acre annual registration fee. If a claimant failed to register, the mineral rights would revert to the surface fee owner. The judge ruled that earlier laws and bills, similar to the 1974 law, pointed to extinguishing mineral rights owned by one person and giving them without cost to another. The law was challenged by the Northwestern Railway and the Milwaukee Road which own extensive mineral rights in the State.

The potential for a mining boom in Wisconsin prompted a request for an increase in the number of State mine inspectors. The mine inspection unit of the Wisconsin Industry, Labor and Human Relations Department noted that exploration activity for copper and zinc-copper may necessitate additional inspections, but full-scale mining in the State is not expected for several years. A more immediate reason for requesting the increase was the prospect of reopening zinc mines in southwestern Wisconsin. The mine safety unit is also charged with inspecting tunnels, quarries, and sand and gravel pits as well as enforcing safety regulations covering use of explosives.

With the increase in mineral activity, the Geological and Natural History Survey was called upon to investigate, interpret,

and distribute data and information regarding geologic, water, and other resources. To assist Federal, State, and local decision-makers in planning for the future of Wisconsin, the Survey, in collaboration with the U.S. Geological Survey, prepared a major report entitled "The Mineral and Water Resources of Wisconsin." The report described each of the various types of mineral deposits known in the State and the

fundamental geological structures that would indicate where other deposits might be found. The broad distribution and availability of surface water and groundwater and the past and future water uses are also described in the report.

In addition to the above report, some of the more important documents describing mining and mineral resources in Wisconsin were published during 1976.³

REVIEW BY MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Baraboo Quartzite Co., Inc., continued to produce deburring and burnishing media from a quartzite deposit near Baraboo in Sauk County. The stone, as quarried, is crushed and screened to uniform sizes. The firm produces about 15 sizes of abrasives usually used in metals stamping plants and sells the material in 100-pound bags. Total output and value of the product during 1976 increased over that for 1975.

Cement.—Each of the three producing companies in the State registered gains in shipments during 1976 compared with that of 1975, but statewide totals showed a substantial decrease because of the closing of the Marquette Co.'s plant in Milwaukee the previous year. Overall decreases in quantity and value were 25% and 19%, respectively. Medusa Cement Co., Manitowoc County, produced Types III, waterproof, and other portland cements, as well as masonry cement. The firm was the only producer of white cement in the State. Grinding facilities for producing portland cement from partially prepared materials from outside the State were operated by Universal Atlas Cement Div. of United States Steel Corp. and Huron Cement Div. of National Gypsum Co., at Milwaukee and Superior.

Nearly 90% of the portland cement was shipped in bulk form with 87% moving by truck and 13% by rail. Principal customers for portland and masonry cement included ready-mix companies, concrete products manufacturers, highway contractors, building material dealers, and other contractors.

Huron Cement completed a study which could double the capacity of its cement terminal in Superior. The study was initiated by the company to analyze the

demand for packaged cement in the Wisconsin, Minnesota, Michigan, and North Dakota market areas. The company has increased its production capacity outside the State and would have sufficient cement available to handle the expected growth in the Superior-Duluth and Minneapolis-St. Paul market areas. A fleet of 6 cement-carrier vessels serves 14 distribution terminals on the Great Lakes covering a market area from North Dakota in the West to central New York State in the East.

Clays.—The total quantity and value of clays produced both increased compared with that of the previous year. The only producer in the State during 1976 continued to be Oakfield Shale Brick & Tile Co., which produced common clay and shale from a deposit near Oakfield in Fond du Lac County. The output was used in its nearby brick plant to produce common and face brick.

Lime.—Three companies operating five plants in the State produced more than 325,000 short tons of lime, valued at a record high of more than \$10 million. It was the 15th consecutive year in which a record high value for lime was established. The five plants, producing both quick and hydrated lime, were operated by The Western Lime & Cement Co., with plants in Brown, Dodge, and Fond du Lac Counties, the CLM Corp., with a plant in Douglas County, and the Rockwell Lime Co., with a plant in Manitowoc County.

³ Special Report 6. Zoning and Financial Incentives for Reservation of Mineral Lands in Wisconsin.

Geoscience Information Series Report 12. Copper and Zinc Mining in Wisconsin.

Map 10. Glacial Deposits of Wisconsin: Sand and Gravel Resource Potential.

Bulletin 87. Soils of Wisconsin.

Plant capacities are being increased by some Wisconsin producers. The anticipated need for increased production was brought about, in part, by the U.S. Environmental Protection Agency (EPA) standards for wastewater purification and clean air. Lime is used extensively to scrub stack gases and to purify wastewater. Although most of the new lime kilns installed were fired by natural gas or fuel oil, the firms were aware of the availability problems concerning these fuels and many companies are equipping the newer kilns to burn coal as well as natural gas as fuel. Other companies were refurbishing kilns and equipment removed when the more recent kilns burning natural gas and fuel oil were installed several years ago.

Western Lime & Cement installed a pre-heater kiln combination at its Green Bay plant. The new production equipment, rated at 200 tons per day capacity, can be fired by natural gas, fuel oil, coal, or a combination of gas and oil. Western Lime & Cement ships lime to paper mills, tanneries, water treatment plants, steel mills, food processors, and the construction industry.

During 1976, CLM Corp. installed a third kiln equipped with a gas-oil burner. With the future of natural gas and fuel oil in the State becoming uncertain, all fuel alternatives are being studied. Fuel costs are becoming increasingly important in the economics of lime manufacture as they represent approximately 40% of the total manufacturing costs. Lime produced by

CLM Corp. is sold to customers in Wisconsin, Minnesota, Michigan, North Dakota, South Dakota, Iowa, Illinois, and Canada. Some of the major users of lime are municipal potable water plants, municipal wastewater treatment plants, paper mills, steel mills, and copper mines. The CLM Corp. plant in Superior was idled for more than 6 weeks beginning May 1 when the 35 plant employees went on strike. The striking employees were represented by the United Steelworkers. Employees of the high calcium lime manufacturing plant returned to work after they ratified an agreement containing a wage and benefit hike, including minor improvements in vacation benefits and a cost-of-living escalator.

Perlite, Expanded.—The quantity of expanded perlite from a plant in Milwaukee County operated by W. R. Grace & Co. and a plant in Outagamie County operated by Midwest Perlite Co. remained about the same as that of 1975, while the total value increased more than 17%. The crude perlite expanded at these operations was mined outside the State. The expanded perlite was used primarily for horticultural and agricultural purposes as well as for masonry and cavity fill insulation. Lesser amounts were used for plaster and concrete aggregate.

Sand and Gravel.—Sand and gravel continued to rank as the number one mineral commodity produced in Wisconsin. The 1976 quantity was slightly above that of 1975, totalling nearly 30.9 million tons, valued at slightly more than \$42 million.

Table 4.—Wisconsin: Lime sold or used by producers, by use

Use	1975		1976	
	Quantity (short tons)	Value (thou- sands)	Quantity (short tons)	Value (thou- sands)
Mason's lime	54,445	\$1,835	70,520	\$2,409
Water purification	53,011	1,467	W	W
Sewage treatment	39,056	1,081	47,170	1,467
Basic oxygen furnaces	6,702	185	W	W
Soil stabilization	10,541	355	W	W
Paint	697	19	1,395	41
Other uses ¹	131,274	3,661	206,340	6,142
Total ²	295,726	8,604	325,438	10,058

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

¹ Includes acid mine water neutralization (1976), agriculture, fertilizer (1976), finishing lime, food and food byproducts, insecticides (1975), oil well drilling, paper and pulp, petroleum refining, sand-lime brick (1975), silica brick (1976), sugar refining (1975), tanning, other chemical uses, copper ore concentration, other ore concentration (1976), electric steel furnaces, wire drawing, other metallurgical uses, and uses indicated by symbol W.

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

Nearly 30 million tons of sand and gravel was mined for construction purposes, having an average value per ton of \$1.21. The average value of 1.2 million tons of industrial sand was approximately \$5 per ton. Total production of sand and gravel accounted for 32% of the State total value in 1976. Most of the sand and gravel was used as aggregate or roadbase in the construction industry, while the industrial sand was used for molding, metallurgy, glass manufacture, foundry, blast sand, and other purposes.

There were six more pits operating dur-

ing 1976 than in 1975, and production was from 67 of the 72 counties in the State. There were 325 companies operating at these sites and, except for industrial sand, most of the sand and gravel was used within a short distance of the pit at which it was produced. Most of the production activity was centered in and around the large urban centers of southeastern Wisconsin with the following counties producing more than 1 million tons during 1976: Barron, Dane, Kenosha, Rock, Sheboygan, Washington, and Waukesha.

Table 5.—Wisconsin: Sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Construction:				
Sand -----	NA	NA	10,901	10,009
Gravel -----	NA	NA	18,730	25,739
Total ¹ -----	28,753	34,415	29,630	35,750
Industrial sand -----	1,304	6,165	1,249	6,251
Grand total -----	30,057	40,580	30,879	42,001

NA Not available.

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

Table 6.—Wisconsin: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	7,639	11,698	8,319	12,155
Concrete products (cement blocks, bricks, pipe, etc.) -----	1,808	2,436	1,886	3,038
Asphaltic concrete aggregates and other bituminous mixtures -----	4,122	5,958	5,204	6,278
Roadbase and coverings -----	11,478	11,055	9,707	10,907
Fill -----	3,485	3,056	4,145	2,950
Other uses -----	220	213	370	420
Total ¹ -----	28,753	34,415	29,630	35,750

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

Table 7.—Wisconsin: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Adams	1	8	2	1	56	29
Ashland	2	W	W	1	41	43
Barron	3	343	384	12	1,763	1,048
Bayfield	3	31	35	2	W	W
Brown	6	408	521	6	621	752
Buffalo	1	26	10	1	27	11
Burnett	2	W	104	3	320	316
Calumet	3	360	657	3	93	93
Chippewa	9	377	405	8	422	496
Clark	5	919	1,286	5	874	1,538
Columbia	12	1,046	3,964	11	997	3,961
Crawford	2	W	W	3	157	390
Dane	19	1,081	1,547	21	1,477	1,779
Dodge	9	350	346	8	415	323
Door	12	500	633	11	498	506
Douglas	9	W	W	5	52	76
Dunn	3	150	275	3	198	271
Eau Claire	4	256	805	3	W	W
Florence	1	16	24	3	19	29
Fond du Lac	7	194	206	7	272	267
Forest	1	60	77	2	W	W
Grant	1	W	W	1	10	W
Green	5	190	191	2	W	W
Green Lake	7	530	1,454	7	555	1,832
Iron	3	229	69	3	113	111
Jackson	3	143	264	4	141	276
Jefferson	10	301	401	8	250	287
Juneau	1	46	41	1	22	25
Kenosha	4	649	764	5	1,006	1,526
Kewaunee	3	312	398	7	425	444
La Crosse	2	68	92	2	W	W
Lincoln	7	583	606	9	469	601
Manitowoc	10	585	577	14	893	887
Marathon	7	609	585	8	473	764
Marinette	5	115	162	7	133	320
Oconto	10	697	868	8	529	710
Oneida	8	531	574	9	453	698
Ozaukee	11	1,077	1,420	8	433	605
Pepin	1	11	6	2	20	7
Pierce	7	135	203	5	229	423
Polk	6	513	512	6	573	529
Portage	4	682	770	4	629	765
Price	2	W	W	1	29	32
Racine	7	617	1,413	9	664	658
Richland	2	52	70	2	52	70
Rock	13	1,733	2,486	10	1,536	2,607
Rusk	6	482	607	7	502	462
St. Croix	4	233	173	5	402	457
Sauk	8	W	W	10	320	661
Sawyer	7	205	573	3	129	232
Shawano	8	394	488	8	318	500
Sheboygan	5	617	630	8	1,065	1,605
Taylor	8	454	555	9	732	961
Vilas	4	123	277	6	220	389
Walworth	23	2,551	1,233	20	947	780
Washburn	2	48	71	3	W	W
Washington	10	1,627	1,626	9	1,843	1,905
Waukesha	32	3,970	4,802	32	3,586	3,873
Waupaca	6	348	562	5	600	684
Waushara	6	368	524	4	330	426
Winnebago	11	484	1,039	10	436	1,034
Undistributed ¹	10	1,621	2,207	14	1,512	1,928
Total ²	408	30,057	40,580	414	30,879	42,001

¹ Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

² Includes Langlade, Marquette, Menominee (1976), Outagamie, Vernon, and Wood Counties, and some sand and gravel that cannot be assigned to specific counties (1976).

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

Stone.—Stone was the second leading mineral commodity in Wisconsin, out-ranked only by sand and gravel. The 1976 output was 20.7 million tons, valued at \$41.3 million. Both dimension and crushed and broken stone were produced from sedimentary, igneous, and metamorphic rocks found in the State. Although crushed and broken stone accounted for more than 99% of the total stone quantity, dimension stone values accounted for about 11% of the total stone value.

Dimension stone was quarried by 29 companies at 35 quarries. Output increased 4% to nearly 72,000 tons, valued at \$4.6 million. Granite quarried in Marathon and Marquette Counties in central Wisconsin accounted for more than 61% of the value of dimension stone produced in the State. Leading producers of dimension limestone

were Halquist Stone Co., Inc., in Waukesha County and Oakfield Stone Co. in Fond du Lac County. Most of the dimension limestone production came from Waukesha County, an area long noted as the center of the dimension limestone industry in the State. Among all of the States, Wisconsin ranked second in the output of dimension limestone. A small quantity of dimension sandstone was produced in Marathon and Wood Counties for use as house stone veneer.

Crushed and broken stone was produced by 126 companies at 355 quarries in 47 of the State's 72 counties. Most of the crushed and broken stone was used as aggregate, roadbase material, or for other construction purposes. Most of the crushed and broken stone produced in Wisconsin was limestone and dolomite.

Table 8.—Wisconsin: Production of dimension stone,¹ by use

Use	1975			1976		
	Short tons	Cubic feet	Value (thousands)	Short tons	Cubic feet	Value (thousands)
Rough blocks -----	15,580	194,700	\$183	2,078	25,980	\$26
Irregular-shaped stone -----	10,220	127,300	169	8,676	108,400	188
Rubble -----	6,864	84,396	102	22,240	278,000	328
Rough monumental -----	3,357	22,170	357	4,044	25,960	456
Rough flagging -----	5,437	67,960	109	5,228	65,350	107
Cut stone -----	388	4,573	36	1,831	22,760	164
Sawed stone -----	2,913	34,788	156	2,222	26,390	114
House stone veneer -----	13,510	167,700	636	18,330	229,200	792
Dressed construction -----	5,481	68,057	113	2,976	37,200	71
Dressed monumental -----	3,288	37,680	2,218	3,285	36,710	2,326
Curbing -----	W	W	W	257	3,115	4
Other uses ² -----	2,209	27,040	39	592	7,376	15
Total ³ -----	69,248	836,460	4,119	71,764	866,440	4,591

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

¹ Includes granite, limestone, and sandstone.

² Includes dressed flagging, other miscellaneous uses, and uses indicated by symbol W.

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

Table 9.—Wisconsin: Production of crushed stone,¹ by use
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Agricultural limestone -----	1,065	2,571	1,275	3,001
Concrete aggregate -----	1,115	1,857	1,265	2,112
Bituminous aggregate -----	1,190	2,033	1,355	2,334
Macadam aggregate -----	479	854	578	1,123
Dense-graded roadbase stone -----	8,087	11,960	7,329	11,130
Surface treatment aggregate -----	1,859	2,895	2,252	3,498
Other construction aggregate and roadstone -----	3,148	5,406	3,584	5,989
Riprap and jetty stone -----	379	909	156	477
Railroad ballast -----	1,012	2,124	1,060	2,415
Filter stone -----	16	36	24	W
Lime manufacture -----	W	W	134	369
Bedding material -----	3	8	W	W
Drain fields -----	W	8	W	11
Fill -----	67	67	69	90
Other uses ² -----	2,077	5,314	1,585	4,196
Total ³ -----	20,497	36,037	20,667	36,747

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

¹ Includes granite, limestone, sandstone and quartzite, traprock, and miscellaneous stone.

² Includes stone used in roofing granules, abrasives, flux stone, other filler (1975), disinfectant (1975), other miscellaneous uses, and items indicated by symbol W.

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

Table 10.—Wisconsin: Stone sold or used by producers, by kind
(Thousand short tons and thousand dollars)

Kind of stone	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Granite:						
Dimension -----	6	7	2,593	6	7	2,820
Crushed and broken -----	11	776	1,028	8	886	1,193
Total ¹ -----	17	783	3,622	14	893	4,014
Limestone and dolomite:						
Dimension -----	26	62	1,503	25	64	1,750
Crushed and broken -----	350	17,452	28,990	339	17,705	29,768
Total ¹ -----	368	17,514	30,493	356	17,768	31,518
Other stone:²						
Dimension -----	5	1	23	4	1	21
Crushed and broken -----	8	2,269	6,019	8	2,077	5,785
Total ¹ -----	13	2,269	6,042	12	2,078	5,806
Total stone:²						
Dimension -----	37	69	4,119	35	72	4,591
Crushed and broken -----	369	20,497	36,037	355	20,667	36,747
Grand total -----	398	20,566	40,156	382	20,739	41,338

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

² Includes quartzite, sandstone, traprock, and other miscellaneous stone.

Table 11.—Wisconsin: Crushed limestone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value
Brown	14	921	1,525	13	903	1,404
Buffalo	8	307	618	11	418	778
Calumet	8	398	511	9	394	510
Columbia	5	210	358	4	W	W
Crawford	13	249	338	14	300	447
Dane	24	828	1,382	24	1,021	1,698
Dodge	12	753	1,056	11	686	1,172
Door	5	101	118	5	51	68
Dunn	5	85	158	6	147	324
Fond du Lac	12	604	912	14	671	958
Grant	33	751	1,141	22	714	1,162
Green	19	385	753	18	407	540
Green Lake	4	96	132	4	76	106
Iowa	18	576	727	15	489	693
Jefferson	3	108	197	4	86	145
La Crosse	8	806	1,114	5	723	994
Lafayette	19	431	567	15	521	714
Manitowoc	3	425	852	2	W	W
Marquette	1	29	W	1	48	W
Monroe	6	460	603	9	180	239
Outagamie	6	635	1,030	6	657	1,076
Ozaukee	2	W	W	1	99	W
Pepin	2	80	W	4	179	W
Pierce	8	269	W	7	301	W
Folk	1	32	84	1	46	129
Racine	3	851	2,082	4	872	1,947
Richland	7	205	W	11	W	W
Rock	15	234	372	18	338	513
St. Croix	6	259	454	7	239	543
Sauk	8	207	W	7	W	W
Shawano	2	W	154	2	W	W
Sheboygan	1	W	40	1	W	W
Trempealeau	12	370	W	8	334	W
Vernon	14	347	598	16	414	726
Walworth	1	54	99	1	W	141
Waukesha	14	2,146	3,676	10	2,157	3,664
Waupaca	1	19	37	1	26	42
Winnebago	14	1,438	2,413	15	1,433	2,450
Undistributed ¹	13	1,777	4,933	13	2,776	6,582
Total ²	350	17,452	28,990	339	17,705	29,768

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

¹ Includes Douglas, Juneau, Marinette, Milwaukee, Oconto, and Washington Counties.

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

Sulfur (Recovered Elemental).—Elemental sulfur was recovered as a byproduct from the Murphy Oil Corp. refinery in Superior. The recovery and concurrent sales during 1976 dropped to 171 long tons, a decrease of more than 73% from that of 1975. The respective dollar value also plunged an equal percentage amount to \$2,736. All the sulfur recovered was shipped to a consumer in central Minnesota.

Vermiculite.—Exfoliated vermiculite was produced at a plant operated by Koois, Inc., in Kenosha County, and at a plant operated by W. R. Grace & Co. in Milwaukee County. The material at both plants was produced from crude vermiculite shipped in from outside the State. The quantity of exfoliated vermiculite used for fertilizer showed

a marked increase, accounting for more than one-half the total output, while that used for block insulation showed a significant decrease in the quantity used. Loose fill insulation remained an important use of exfoliated vermiculite, with minor uses attributed to concrete aggregates, horticulture, plaster aggregates, and soil conditioning. The total quantity of exfoliated vermiculite produced in the State showed an increase of about 15%, while the overall value decreased by more than 16%.

METALS

Copper-Zinc.—A mining operation planned by Flambeau Mining Corp., a wholly owned subsidiary of Kennecott

Copper Corp., about 1½ miles southwest of Ladysmith, Rusk County, was described in an EIS prepared by the DNR. An open pit mine covering 55 acres to a maximum depth of 285 feet would be required to develop the deposit, which was described as a sulfide-bearing formation, about 2,400 feet long, 50 feet wide, and extending more than 800 feet beneath the surface. Flambeau acquired a site of 2,750 acres over the deposit. Production from the open pit was estimated at 1,000 tons of crude ore and 4,120 tons of waste rock per day, providing about 160 tons daily of copper concentrate. The concentrates would be shipped to a western refinery for processing. The open pit would be operated for 11 years with the possibility of continuing the operation as an underground mine for an additional 11 years. The company estimated annual production at 11,836 tons of copper, 149,297 ounces of silver, and 13,989 ounces of gold, with a total value estimated at \$16 to \$21 million. The annual payroll for the mine, with about 80 employees in an open pit operation and about 143 in an underground operation, would exceed \$1 million. The initial outlay during the construction phase would be more than \$15 million.

A major concern over the Flambeau proposal was that it may be the first new copper mine in Wisconsin and the standards set by DNR for this operation should establish a precedent for future mine developments. To develop the project, Flambeau needed 12 DNR permits or approvals and other sanctions from the town of Grant, Rusk County, the U.S. Army Corps of Engineers, the Public Service Commission, and the Department of Health and Social Services.

In November, the DNR began public hearings on the Flambeau applications. During the hearings, the Rusk County Board met and voted to withhold action on any mining company request for zoning changes or permits until the State mining and mining tax laws were reformed. The County Board resolution indicated that more mining tax dollars should be returned to the local governments. A revised mining tax plan has been developed and was to be introduced in the 1977 legislative session. Upon being informed of the County Board's decision, the DNR hearings were suspended, thereby delaying the proposed Flambeau venture.

The Flambeau proposal, coupled with the announced discovery of a small zinc-copper deposit near Rhinelander by Noranda Exploration Co. during 1975, increased public awareness of the environmental and economic consequences of mining in Wisconsin. No one was prepared, however, for the announcement by Exxon Co. U.S.A. in May that the firm had discovered a major zinc-copper deposit in northern Wisconsin about 6 miles south of Crandon in Forest County. Test drilling by the company indicated that the zinc-copper deposit might be one of the five largest massive sulfide deposits in North America. Exploration data indicated a mineralized deposit of about 60 million tons, between 200 and 1,675 feet below the surface, underlying an area nearly 1 mile long and a few hundred feet wide. The deposit appeared to average about 6.5% zinc and 1% copper, with much lower values of silver, gold, and lead. The size of the deposit could be much larger as one drill-hole encountered metallic sulfides at a depth of 2,500 feet. Exploration drilling will continue to better define the extent and nature of the deposit. Exxon began feasibility studies regarding mining, but no firm mining plans were developed.

Since the Exxon announcement, several major mining companies have shown interest in mining prospects in the State. More than 20 firms were conducting active exploration programs during 1976. Some of the more active companies in mineral exploration included Exxon, Noranda Exploration, NL Industries, Inc., Phelps-Dodge Corp., and International Nickel Co., Inc. (INCO). Individuals and counties continued to be cautious about contracting with mining companies regarding exploration or mining leases.

Iron Ore.—Jackson County Iron Co., a wholly owned subsidiary of Inland Steel Co., operated a taconite (iron ore) mine and processing plant near Black River Falls. Production from the sole producing facility decreased by more than 16% from the previous year to a little more than 664,000 long tons. Total value of the taconite pellets also decreased, but at a lesser rate than the tonnage, as the price of taconite pellets was increased during January and again in August to 53.1 cents per iron unit. All pellets produced at the Black River Falls operation were shipped by rail to In-

land Steel's Indiana Harbor Works at East Chicago, Ind.

The Jackson County Iron Co. purchased and placed in production several new pieces of equipment. An 11-cubic-yard shovel, costing approximately \$950,000, was assembled at the mine and placed in service early in 1976. Additionally, the firm purchased a new drill and two 85-ton trucks.

Burlington-Northern Co.'s project to construct a \$70 million storage and shiploading facility for iron ore pellets near Superior continued on schedule. At the end of the year, the project was about 90% complete and was scheduled to be in full operation in April 1977. The new transshipment terminal on Allouez Bay was designed to handle the increased production of pellets from taconite operations on the Mesabi iron range of Minnesota. The tonnage of pellets to be handled represents the increased production from the National Steel Pellet Project at Keewatin, Minn., and the entire output from Hibbing Taconite Co. at Hibbing, Minn. The transshipment complex includes a taconite pellet stockpile area with an initial capacity of 5.2 million long tons, more than 4 miles of conveyors and transfer buildings, and a dockside shiploader. The shiploading structure, 130 feet high and 900 feet long, has 36 elevated storage bins with a total capacity of 72,000 long tons of taconite pellets. The dock is designed to accommodate lake carriers of up to 1,000 feet long. More than \$1 million was spent for dust control and collection with an additional \$1.5 million spent for other environmental safeguards. To handle the increased activities at this terminal in 1976 the railroad purchased 400 new ore cars at a cost of \$12.5 million for use in hauling pellets from Minnesota mines to the new facility.

Zinc and Lead.—Eagle-Picher Industries, Inc., the sole zinc producer in the State, increased the production of zinc concentrate by 11% over that of 1975. A decrease in unit price for the concentrate was reflected in the total dollar values for 1976 which showed less than a 5% increase over that for 1975. All of the crude ore mined during 1976 by Eagle-Picher came from the Shullsburg and Bear Hole mines in Lafayette County. The ore was milled at the Shullsburg mill just across the border in Illinois. A small quantity of lead was

recovered as a byproduct of the zinc operations.

Eagle-Picher made application to the Wisconsin DNR for permits to reopen two mines in southwestern Wisconsin. The company planned to have the Elmo mine in Grant County and the Crawhall mine in Lafayette County in production in 1977. These two operations were expected to provide an additional 1,400 tons of ore daily to the company's output. The Elmo mine was last operated in 1971, and the Crawhall mine was closed in 1970. The firm intended to open the mines early in the year, but U.S. Environmental Protection Agency and Wisconsin DNR regulations in effect at that time would have made the operations unprofitable. At issue was the zinc content of the water that had to be continually pumped out of the mines and discharged into nearby streams. Regulations required that the zinc content be less than 0.5 parts per million. The firm estimated that a plant to reduce the zinc concentration would cost about \$843,000 to construct and about \$1.5 million a year to operate. The Federal guidelines were rescinded in May and the DNR issued the appropriate permits. The firm stated that it would take 6 months and cost an estimated \$600,000 to reopen the two mines.

MINERAL FUELS

Coke.—The coke produced by the Milwaukee Solvay Coke Co., a division of Pickands Mather & Co., at its plant in Milwaukee County, was used principally by foundries and other industrial users. Shipments from the sole producing coke plant in the State were primarily to consumers in Wisconsin and surrounding States.

Peat.—The production of moss and humus peat from bogs and processing plants in Wisconsin declined to 10,598 short tons during 1976. With the drop in output, there was a concurrent decline in total value. All of the peat and peat products were produced in Waukesha County by Bogda's Top Soil & Excavating Co., Certified Peat & Sod, Inc., and Demilco, Inc., a division of Nitragin Sales Corp. All of the peat was sold for horticultural purposes.

Petroleum Refineries.—The only petroleum refinery in the State, operated by Murphy Oil Corp. in Superior, continued

its search for a new crude oil supply to replace declining Canadian imports. The refinery is virtually 100% dependent upon Canadian crude oil and has been given a priority one classification by the U.S. Energy Administration, indicating this total or substantial dependence. The refinery has a 42,500-barrel-per-day capacity, but near the end of the year was operating at about 60% of capacity because of limited supplies. A minimum of 15,000 barrels per day input is required for this refinery to be marginal. Should the refinery be unable to obtain sufficient supplies for at least marginal operation, the company would consider dismantling the facility and moving it to a geographic area with better supplies.

Murphy Oil Corp. and six other oil companies have committed \$5 million for preliminary design studies of a \$500 million Kitimat-Edmonton pipeline to solve crude oil supply cutbacks facing Canadian-dependent refineries in border States. The consortium is proposing construction of a pipeline from Kitimat, British Columbia,

Canada, to connect with an existing crude oil pipeline between Edmonton, Alberta, Canada, and Superior, Wis. This proposed project would make oil from the North Slope of Alaska available to the northern tier refineries. Any route selected to utilize Alaskan crude oil to offset the cutbacks in Canadian crude oil would require about 2 years for construction, following issuance of all necessary permits.

During 1976, Murphy Oil was the first U.S. firm to arrange a swap with eastern Canadian crude oil users. Crude oil from Alberta had difficulty in reaching eastern Canadian refineries. The Canadian Government was willing to allow an extra barrel of oil to flow through the inter-provincial pipeline to Superior for each U.S. barrel shipped across the border to Toronto and Montreal. The agreement allowed for an exchange of 3,000 barrels per day. Murphy Oil Corp. will attempt to obtain other swap arrangements to replace declining crude oil allocations until a permanent solution is reached.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Baraboo Quartzite Co., Inc.	Box 123 Baraboo, Wis. 53913	Quarry, plant ----	Sauk.
Cement:			
Medusa Cement Co., a division of Medusa Corp.	Box 5668 Cleveland, Ohio 44101	Dry process plant -	Manitowoc.
National Gypsum Co., Huron Cement Div.	17515 West 9 Mile Rd. Southfield, Mich. 48075	Grinding plant only	Douglas.
Universal Atlas Cement Div., United States Steel Corp.	U.S. Steel Building 600 Grant St. Pittsburgh, Pa. 15230	----do -----	Milwaukee.
Clay and shale:			
Oakfield Shale Brick & Tile Co.	Box 337 Oakfield, Wis. 53065	Pit, plant -----	Fond du Lac.
Coke:			
Milwaukee Solvay Coke Co., a division of Pickands Mather & Co.	311 East Greenfield Ave. Milwaukee, Wis. 53204	Coke ovens -----	Milwaukee.
Iron ore:			
Jackson County Iron Co., a subsidiary of Inland Steel Co.: Black River Falls ----	30 West Monroe St. Chicago, Ill. 60603	Mine, concentrator, agglomerator.	Jackson.
Iron oxide pigments, finished:			
Delta Color & Supply Co --	1050 East Bay St. Milwaukee, Wis. 53217	Plant -----	Milwaukee.
Lime:			
CLM Corp -----	12th Ave. West & Waterfront Duluth, Minn. 55802	Quicklime, hydrated lime.	Douglas.
Rockwell Lime Co -----	Route 2, Box 124 Manitowoc, Wis. 54220	----do -----	Manitowoc.
The Western Lime & Cement Co.: Green Bay plant -----	Box 2076 Milwaukee, Wis. 53201	----do -----	Brown.
Knowles plant -----		----do -----	Dodge.
Eden plant -----		----do -----	Fond du Lac.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Peat:			
Bogda's Top Soil & Excavating Co.	12600 West Cleveland Ave. New Berlin, Wis. 53151	Bog, processing plant.	Waukesha.
Certified Peat & Sod, Inc.	19000 West Lincoln Ave. New Berlin, Wis. 53151	-----do -----	Do.
Demilco, Inc., a division of Nitragin Sales Corp.	3101 West Custer Ave. Milwaukee, Wis. 53209	-----do -----	Do.
Perlite, expanded:			
Construction Products Div., W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant	Milwaukee.
Midwest Perlite Co	542 West Linberg Appleton, Wis. 54911	-----do -----	Outagamie.
Petroleum refineries:			
Murphy Oil Corp	Box 2066 Superior, Wis. 54880	Refinery	Douglas.
Sand and gravel:			
Construction sand and gravel:			
B. R. Amon & Sons Co	Route 3 Elkhorn, Wis. 53121	Pits, plants	Jefferson, Kenosha, Racine, Rock, Walworth.
Janesville Sand & Gravel Co.	Box 427 Janesville, Wis. 53545	Pit, plants	Rock.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577	Pits, plants	Barron, Chippewa, Clark, Dunn, Eau Claire, Lincoln, Oconto, Oneida, Ozaukee. Pierce, St. Croix, Sauk, Shawano, Sheboygan, Vilas, Walworth, Washington, Waukesha,
McHenry Sand & Gravel Co., Inc.	920 North Front St. McHenry, Ill. 60050	Pit, plant	Kenosha.
Madison Sand & Gravel Co.	Box 3098 Madison, Wis. 53704	Pits, plants	Dane.
Mann Brothers, Inc	Box 48 Elkhorn, Wis. 53121	-----do -----	Barron, Jefferson Walworth, Waukesha.
Plautz Brothers, Inc	Route 1, Box 47 Willard, Wis. 54498	-----do -----	Chippewa, Clark, Jackson, Taylor, Wood.
State Sand & Gravel Co.	10833 West Watertown Plank Rd. Milwaukee, Wis. 53226	-----do -----	Waukesha.
Wisota Sand & Gravel Co.	Box 1268 Eau Claire, Wis. 54701	-----do -----	Barron, Rusk, Washington.
Industrial sand:			
C. A. Chier Sand Co	Box 97 Fairwater, Wis. 53981	Pit, plant	Green Lake.
Industrial Sand Div., Martin Marietta Corp.	110 East Main St. Rockton, Ill. 61072	-----do -----	Columbia.
Manley Bros. of Indiana, Inc., Hanover Div.	Box 67 Chesterton, Ind. 46375	-----do -----	Rock.
Stone:			
Granite:			
Anderson Bros. & Johnson Co.	Box 26 Wausau, Wis. 54401	Quarries, plant	Marathon.
Ben Gottschalk, Inc	Route 1 Mosinee, Wis. 54455	-----do -----	Do.
Lake Wausau Granite Co.	Box 397 Wausau, Wis. 54401	Quarry, plant	Do.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Stone—Continued			
Limestone and dolomite:			
Courtney & Plummer, Inc.	Box 767 Neenah, Wis. 54956	Quarries, plants	Calumet, Outagamie, Winnebago.
Daanen & Janssen	Box 127 De Pere, Wis. 54115	-----do-----	Brown.
Eden Stone Co., Inc.	Route 1 Eden, Wis. 53019	Quarries, plant	Fond du Lac.
Franklin Stone Products, Inc.	7220 South 68th St. Hales Corners, Wis. 53132	Quarry, plant	Milwaukee.
Halquist Stone Co., Inc.	N52 W23564 Lisbon Rd. Sussex, Wis. 53089	Quarries, plant	Waukesha.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577	Quarries, plants	Buffalo, Crawford, Dunn, Green, Juneau, La Crosse, Marquette, Pepin, Pierce, Richland, St. Croix. Sauk, Trempealeau, Vernon.
Landwehr Materials, Inc.	Route 2 Appleton, Wis. 54911	Quarry, plant	Outagamie.
C. C. Linck, Inc.	1226 North Center St. Beaver Dam, Wis. 53916	Quarries, plants	Dodge, Fond du Lac, Green Lake.
Mayville White Lime Works.	Box 25 Mayville, Wis. 53050	Quarry, plant	Dodge.
Oakfield Stone Co.	Box 221 Oakfield, Wis. 53065	-----do-----	Fond du Lac.
Arthur Overgaard, Inc.	Box 87 Elroy, Wis. 53929	Quarries, plants	Buffalo, Juneau, La Crosse, Monroe.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, Ill. 60525	-----do-----	Milwaukee, Racine, Waukesha, Winnebago.
G. A. Watson	Barneveld, Wis. 53507	-----do-----	Iowa and Lafayette.
Waukesha Lime & Stone Co.	Route 5, Highway 164 Waukesha, Wis. 53186	Quarry, plants	Waukesha.
Wilbur Lime Products	544 East Sixth St. Trempealeau, Wis. 54661	Quarries, plants	Trempealeau.
Sandstone and quartzite:			
Foley Bros., Inc.	Rock Springs, Wis. 53961	Quarry, plant	Sauk.
Minnesota Mining & Manufacturing Co.	3M Center St. Paul, Minn. 55101	Quarries, plant	Marathon.
Traprock (basalt):			
Bryan Dresser Trap Rock, Inc.	3750 Washington Ave. North Minneapolis, Minn. 55412	Quarry, plants	Polk.
GAF Corp.	Box 630 Pembine, Wis. 54156	Quarry, plant	Marinette.
Sulfur, recovered elemental:			
Murphy Oil Corp.	Box 2066 Superior, Wis. 54880	Byproduct sulfur recovery plant.	Douglas.
Vermiculite, exfoliated:			
Construction Products Div., W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant	Milwaukee.
Koos, Inc.	4500 13th Court Kenosha, Wis. 53140	-----do-----	Kenosha.
Zinc and lead:			
Eagle-Picher Industries, Inc.	Box 406 Galena, Ill. 61036	Mine	Lafayette.
Bear Hole	-----	Mine, mill	Do.
Shullsburg	-----	-----	-----

The Mineral Industry of Wyoming

By Charles A. Koch¹

The value of mineral production in Wyoming during 1976 increased to a record \$1.85 billion from \$1.64 billion in 1975. This was the third year that value had surpassed 1 billion dollars. On a per capita basis this amounted to about \$4,748 per individual, approximately 9% over that of 1975. The principal mineral commodities ranked by value were crude oil, sodium carbonate, coal, natural gas, and uranium. Energy minerals were valued at \$1.51 billion or about 81% of the total value. The 1976 increase in mineral value of 13% resulted from increases in production of the major commodities except petroleum which had a slight decline.

Wyoming continued to be the leading producer of petroleum in the Rocky Mountain region and retained the rank of fifth in the Nation. Production for the year declined at a rate of 1.3% compared with 2.9% in 1975 and a national decline of 2.6%. The marketed quantity of natural gas increased 4% and the value increased by 27%.

Coal production increased by 7 million tons from 1975 to 1976 after an increase of only 3.1-million-tons from 1974 to 1975. The reason for this increase was primarily the expansion at the Belle Ayr mine and full operation at the Jim Bridger mine.

Uranium production increased by about 1.2 million pounds after showing a production decrease in 1975. The 1976 production was far below the record production of about 10 million pounds in 1973. Exploration for and development of new mines continued at a high level during the year. Wyoming continued to rank second in both production and reserves behind New Mexico.

Wyoming was again the leading producer of natural sodium carbonate and was also

first in the Nation in reserves. All the producers increased production over that of 1975. Texasgulf, Inc., was officially added to the producer list during 1976. The expansion at FMC Corp's Green River plant was completed and brought the plant capacity to 2.5 million tons per year. The expansion included a new coal-fired powerplant, the only trona plant in the State fired by coal.

Demand for bentonite continued to increase and to meet these demands, expansions were undertaken. Dresser Industries, Inc., was about 75% finished with the construction of a new plant which will boost production capacity by 50%. The Baroid Div. of NL Industries, Inc., increased tonnage about 10% through plant expansion.

The U.S. Bureau of Land Management collected more than \$114 million through its various resource programs in Wyoming during fiscal year 1976. More than \$38 million was returned to the State. Most of the receipts were from mineral royalties and permit fees.

Dedication of the new Wyoming Geological Survey headquarters occurred in September. The new facility was needed to handle the evergrowing demand for information on the State's mineral resources and geology.

Governor Ed Herschler and Secretary of the Interior Thomas S. Kleppe signed an agreement which gave Wyoming the right to oversee the reclamation of Federal coal lands in Wyoming. Under the agreement the Department of Interior agreed that a Federal coal lessee must comply with State laws and regulations regarding reclamation.

A study of State-owned coal lands and an examination of the geothermal energy potential of Wyoming were the first of two

¹ State Liaison Officer, Bureau of Mines, Cheyenne, Wyo.

Table 1.—Mineral production in Wyoming¹

Mineral	1975		1976	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons..	2,582	\$36,046	2,697	\$40,015
Coal (bituminous) ----- do.....	23,804	160,447	30,836	215,936
Gem stones -----	NA	140	NA	147
Gypsum ----- thousand short tons..	271	902	317	1,280
Iron ore (usable), thousand long tons				
gross weight..	2,039	26,792	2,139	29,461
Natural gas ----- million cubic feet..	316,123	106,533	328,768	134,795
Natural gas liquids:				
Natural gasoline and cycle products				
thousand 42-gallon barrels..	2,909	17,694	3,044	19,866
LP gases ----- do.....	6,061	29,578	6,681	35,677
Petroleum (crude) ----- do.....	135,943	983,785	134,149	971,235
Sand and gravel ----- thousand short tons..	4,328	10,746	5,470	10,782
Stone ----- do.....	2,882	7,618	2,757	7,630
Uranium (recoverable) ----- thousand pounds..	6,862	84,406	8,064	129,823
Value of items that cannot be disclosed:				
Cement, feldspar, lime, phosphate rock, and sodium carbonate (natural) -----	XX	179,751	XX	254,952
Total -----	XX	1,644,438	XX	1,851,599
Total 1967 constant dollars -----	XX	650,704	XX	P 665,650

^P Preliminary. NA Not available. XX Not applicable.

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

Table 2.—Value of mineral production in Wyoming, by county
(Thousands)

County	1975	1976	Minerals produced in 1976 in order of value
Albany -----	\$9,153	\$11,220	Cement, petroleum, stone, sand and gravel, clays, gypsum.
Big Horn -----	41,231	42,572	Petroleum, clays, natural gas, gypsum, sand and gravel, lime.
Campbell -----	252,112	271,881	Petroleum, coal, natural gas, natural gas liquids, sand and gravel, stone.
Carbon -----	127,770	146,254	Coal, uranium, natural gas liquids, natural gas, petroleum, sand and gravel, stone.
Converse -----	122,004	131,591	Petroleum, uranium, coal, natural gas liquids, natural gas, sand and gravel.
Crook -----	37,437	39,144	Petroleum, clays, stone, sand and gravel, natural gas.
Fremont -----	131,606	173,488	Uranium, petroleum, iron ore, natural gas, natural gas liquids, sand and gravel, feldspar.
Goshen -----	343	543	Lime, sand and gravel, petroleum.
Hot Springs -----	W	80,399	Petroleum, natural gas, coal.
Johnson -----	33,252	32,483	Petroleum, clays, natural gas, natural gas liquids, sand and gravel.
Laramie -----	W	5,115	Petroleum, stone, sand and gravel, natural gas.
Lincoln -----	32,286	50,267	Coal, natural gas liquids, phosphate rock, natural gas, petroleum, sand and gravel, stone.
Natrona -----	106,183	103,335	Petroleum, uranium, natural gas, natural gas liquids, sand and gravel, clays.
Niobrara -----	4,015	4,021	Petroleum, natural gas.
Park -----	W	201,054	Petroleum, natural gas, natural gas liquids, gypsum, sand and gravel.
Platte -----	12,514	13,440	Iron ore, stone, petroleum, sand and gravel, natural gas.
Sheridan -----	W	W	Coal, petroleum, sand and gravel.
Sublette -----	36,386	39,322	Petroleum, natural gas, sand and gravel, natural gas liquids, stone.
Sweetwater -----	263,920	354,429	Sodium carbonate, petroleum, natural gas, coal, natural gas liquids, sand and gravel.
Teton -----	W	W	Sand and gravel, stone.
Uinta -----	722	714	Natural gas liquids, clays, sand and gravel, petroleum, natural gas.
Washakie -----	19,714	21,200	Petroleum, natural gas, clays, natural gas liquids, lime, sand and gravel.
Weston -----	14,641	14,856	Petroleum, clays, sand and gravel, natural gas, clays, stone.
Undistributed ¹ -----	399,146	114,269	
Total ² -----	1,644,438	1,851,599	

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

¹ Includes value of mineral production 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.

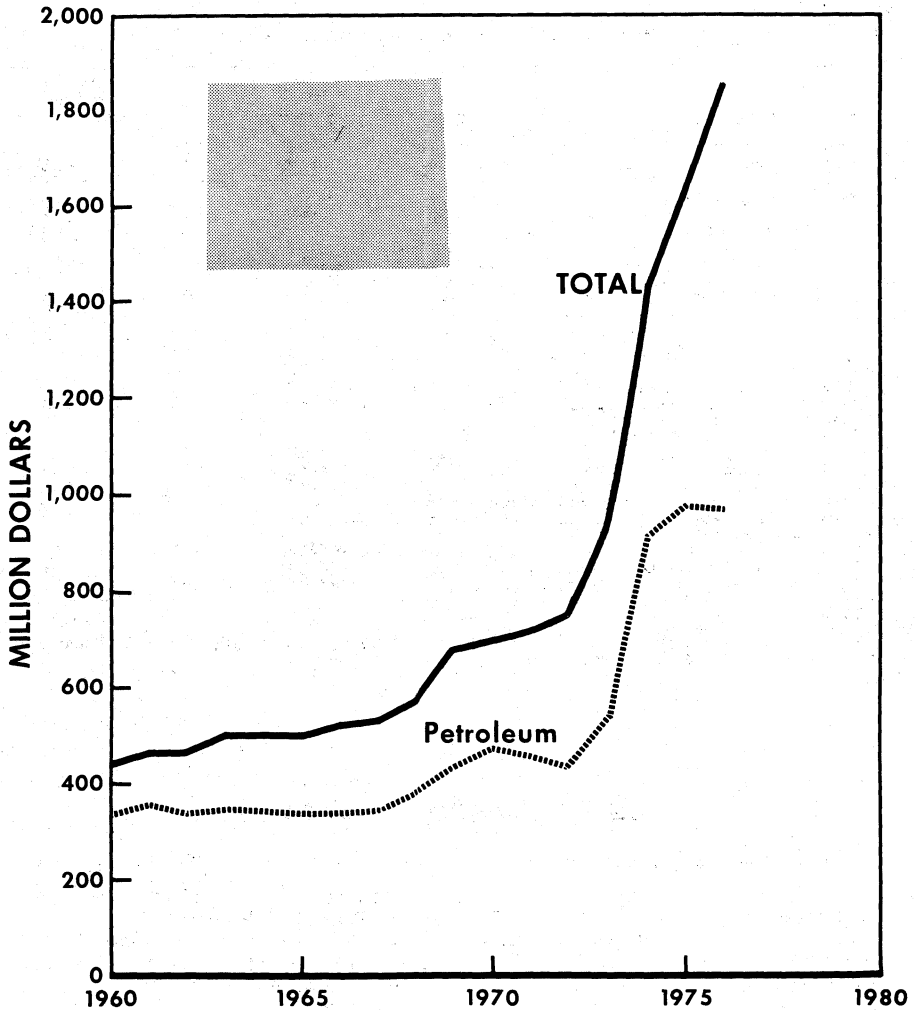


Figure 1.—Value of petroleum and total value of mineral production in Wyoming.

publications in a new series from the Geological Survey of Wyoming. The new public information series is devoted to short technical treatments of topics important to the people of Wyoming. The series was planned as a moderately priced timely resource. "Geothermal Resources Present and Future Demand for Power and Legislation in the State of Wyoming," by Dr. Edward Decker of the Geology Department at the University of Wyoming, was the first in the

series. It deals with thermal resources, some analyses of the spring waters, and other topics. "State-Owned Coal Lands in Wyoming," the second booklet in the series, was a report presented by Gary Glass, staff geologist, State Geological Survey, to the Senate Mines and Minerals committee during the 1976 Wyoming Legislative Session. The report examined current trends in State coal leases and provided a complete sketch of the leasing situation.

Table 3.—Indicators of Wyoming business activity

	1975	1976 ^p	Change, percent
Employment and labor force, annual average:			
Total civilian labor force -----thousands--	175.5	179.0	+2.0
Unemployment -----do-----	7.2	7.0	-2.8
Employment (nonagricultural):			
Mining -----do-----	18.9	20.5	+8.5
Manufacturing -----do-----	8.3	8.4	+1.2
Contract construction -----do-----	14.3	14.7	+2.8
Transportation and public utilities -----do-----	12.5	12.8	+2.4
Wholesale and retail trade -----do-----	31.8	34.7	+9.1
Finance, insurance, real estate -----do-----	4.5	5.1	+13.3
Services -----do-----	21.1	23.0	+9.0
Government -----do-----	34.5	36.2	+4.9
Total nonagricultural employment -----do-----	145.9	155.4	+6.5
Personal income:			
Total -----millions--	\$2,277	\$2,593	+13.9
Per capita -----do-----	\$6,060	\$6,642	+9.6
Construction activity:			
Number of private and public residential units authorized			
Value of nonresidential construction -----millions--	2,637	4,125	+56.4
Value of State road contract awards -----do-----	\$28.1	\$38.1	+35.6
Shipments of portland and masonry cement to and within the State -----thousand short tons--	\$48.0	\$70.0	+45.8
320	423	+32.2	
Mineral production value:			
Total crude mineral value -----millions--	\$1,644.4	\$1,851.6	+12.6
Value per capita, resident population -----do-----	\$4,374	\$4,748	+8.6
Value per square mile -----do-----	\$16,795	\$18,910	+12.6

^p Preliminary.

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

REVIEW BY MINERAL COMMODITIES

MINERAL FUELS

Coal (Bituminous).—Wyoming's coal production continued to increase setting another production record in 1976. Coal production surpassed 30 million tons per year with a production of 30.8 million tons compared with 23.8 million tons in 1975. The value of the production increased from \$160.4 million to \$215.9 million, a 35% increase over 1975. Wyoming ranked seventh nationally in production bypassing Indiana which was seventh in 1975. Carbon County continued to lead in production followed by Campbell, Lincoln, and Sweetwater Counties. Wyoming had three new mines open during the year, two surface and one underground. According to the 1977 Keystone Coal Industry Manual, Wyoming had 9 mines in the top 50 mines in the United States.

On a statewide basis, 90% of the coal was used for generating electricity. Wyom-

ing coal continued finding its way to out-of-State markets as a record 21.6 million tons was shipped, primarily east.

According to the Annual Report of the State Inspector of Mines, the five major companies, including subsidiaries, produced about 28.7 million tons or 93% of the State's production. The companies and their production follow: Arch Minerals Corp., 8.1 million tons from three mines; Amax Coal Co., 7.2 million tons from one mine; Pacific Power & Light Co., 6.3 million tons from two mines; Kemmerer Coal Co., 4.1 million tons from two mines; and Peter Kiewit & Sons Co., 3.0 million tons from two mines. The State had three new coal mines open during the year, two surface mines, Cordero Mining Co.'s Cordero mine and FMC Corp.'s Skull Point mine which opened at yearend, and one underground mine, Stansbury Coal Co.'s Stansbury mine.

The mine of Cordero Mining Co., a wholly owned subsidiary of Sunoco Energy

Development Co. (SUNEDCO) is in the Powder River Basin, about 22 miles south of Gillette in Campbell County. Coal was first shipped from the mine in December. When operating at full capacity in the early 1980's the mine will be producing about 12 million tons of coal per year. Engineering studies have confirmed the feasibility of expanding the mine to an ultimate capacity of 24 million tons per year. The coal was sold to the City Public Service Board of San Antonio, Tex., under a 20-year contract. The utility will use the coal to replace the 47 billion cubic feet of natural gas it has been burning each year to generate electricity.

After being closed since 1957, the Stansbury underground mine was reopened as a joint venture of Rocky Mountain Energy Co. (RME) and Ideal Basic Industries Corp., both of Denver, Colo. The operation, about 10 miles north of Rock Springs, represents an investment of \$25 million. In April 1976 the mine began producing coal on a limited basis. Production could be up to the design capacity of 1.2 million tons per year by mid-1977. Five minable seams are expected to be mined during the projected 50-year life of the mine, but only the No. 3 seam is being mined while progress is made toward getting the No. 1 seam into production. The operating company, Stansbury Coal Co., has a 20-year contract with Ideal and Texasgulf, Inc.

FMC Corp. in late October shipped the first coal from its Skull Point mine near Kemmerer. Morrison-Knudson Co., Inc., operates the mine for FMC. Annual production will be about 600,000 tons of which 400,000 tons will be used by FMC at its iron operations near Green River and 200,000 tons will be converted to form coke at FMC's Kemmerer coke facility. The coke is used at the company's elemental phosphorous plant at Pocatello, Idaho.

Plans for constructing facilities to market extra coal produced by the Bridger Coal Co. were announced by RME. The facility, to be located immediately southeast of the Jim Bridger powerplant, would market an estimated half-million tons of coal per year. The mine is capable of producing more coal than is used by the plant and it is the excess coal RME is proposing to store and market. The facility would consist of a loop track and train load-out facilities. There

are no firm customers nor a definite market for the coal as yet.

RME reported a \$1 billion coal sales contract with a major Midwest utility. The 20-year agreement includes appropriate price escalation clauses and provides for the sale of 3 million tons of coal per year, beginning in early 1979, from a mine near Rock Springs. The agreement was negotiated on behalf of the Black Butte Coal Co., a joint venture between RME and Peter Kiewit & Sons, and is in addition to a previously negotiated sales agreement with Idaho Power Co. which involved an average annual delivery of more than 3 million tons of Black Butte coal beginning in 1980. Kiewit will also be manager of the second joint venture which is expected to produce more than 5 million tons of coal per year by 1980. Coal reserves total more than 200 million tons at Black Butte, Twin Creek, and South Haystack.

The Carter Mining Co. has begun removing overburden at its Rawhide mine north of Gillette, Campbell County. Production from the mine will begin in 1977. Construction is expected to start early in December on the company's second mine, Caballo, about 17 miles south of Gillette. Plans for the new mine call for production of 5 million tons per year which can be expanded to 14 million tons per year. Initial coal shipments from Caballo are expected by mid-1979.

Panhandle Eastern Pipe Line Co. and Peabody Coal Co. announced that the two companies have organized a joint venture to supply western coal to a unit of Middle South Utilities. The new venture, Antelope Coal Co., signed a contract to provide up to 200 million tons of coal over a 40-year period to Systems Fuels, Inc., the energy supply unit of Middle South. The Antelope venture will be operated by Peabody. Systems Fuel's coal purchase agreement calls for delivery of 150 million tons over a 26-year period and a maximum of 200 million tons in 40 years. First delivery under this contract will be made in the early 1980's.

Kerr-McGee Coal Corp. signed a 5-year contract to supply 15 million tons of coal to Western Fuels Association, Inc. The coal will come from Kerr-McGee's East Gillette No. 16 mine and will be used by Cajun Electric Power Cooperative, Inc. of Louisiana. Deliveries will start early in 1979 and continue through 1983. The Louisiana

utility will get the first coal production from the mine which is now under construction. The mine is under lease from the State and contains an estimated 68 million tons of recoverable coal. In another contract with Houston Lighting and Power Co., Kerr-McGee has a coal sales contract totaling more than \$80 million over a 3-year period. Under the agreement, Kerr-McGee will deliver 12.7 million tons of low-sulfur coal from 1978 through 1980 for the utility's W. A. Parish plant in Tompson, Tex. Coal under this contract will come from Kerr-McGee's Jacobs Ranch mine now under construction south of Gillette.

A development drilling program was started north of Rock Springs in early 1977 to determine the quantity and quality of coal for the proposed Long Canyon underground mine. The Long Canyon project initiated by SUNEDCO and RME is expected to yield 78 million tons of coal from the No. 1 seam alone. Four major coal seams over 4 feet thick are targeted for initial development. According to the mining and reclamation plan, construction of the mine could begin in early 1978 with completion scheduled for late 1979. The initial year's production will be about 0.5 million tons building up to an annual production of 2 million tons by 1983.

Atlantic Richfield Co. (ARCO) began construction of its Black Thunder mine located south of Gillette in the Powder River Basin. The mine is expected to produce about 20 million tons per year by 1982 with initial production expected to be about 5.8 million tons per year in 1978. Burlington Northern Railroad is building a 22-mile spur from its Gillette line to ARCO's property, with completion scheduled for late 1977 or early 1978.

The Wyoming Department of Environmental Quality and Amax Coal Co. settled their dispute over construction of a coal preparation plant at the company's Belle Ayr mine. A construction permit was issued and the company agreed to pay \$5,000 in fines for beginning construction before the permit was issued.

The Department of Interior issued a Federal Coal Preference Right Lease to Rosebud Coal Sales Co. on 14,900 acres of federally owned coal deposits in Sweetwater County. The acreage contains about 81 million tons of coal of which 51.5 million tons is surface minable. Rosebud would mine

the lease to help fulfill a supply contract with Idaho Power Co.

Plans were announced for a joint venture company to develop and mine extensive underground deposits of low-sulfur coal in the Hanna area of Carbon County by Dravo Corp. of Pittsburgh, Pa. and RME. The parties executed a letter of intent with a large U.S. electric utility for sale of a major portion of the production. Coal reserves involved amount to about 200 million tons. Final engineering studies for the underground mine are underway, and construction at the site is expected to start early in 1977 with limited production to begin in 1978.

Energy Transportation Systems, Inc. (ETSI) filed suit against three Wyoming railroads seeking easements for its coal slurry pipeline. Filed in U.S. District Court, the separate suits name the Union Pacific Railroad, Burlington Northern Railroad, and Chicago and Northwestern Transportation Co. as defendants. ETSI is seeking a declaratory judgment and restraining orders to allow it to construct the coal slurry pipeline under railroad right-of-way sections in Laramie, Goshen, and Niobrara Counties. The firm plans to move Powder River Basin coal by slurry pipeline to fuel an Arkansas powerplant. ETSI's suit claims the firm has water rights to 20,000 acre-feet of water per year from the Wyoming State Engineer.

Construction began on the \$1.4 billion coal fired Laramie River Station powerplant. Groundwork for the first two of three 500-megawatt plants began during the summer. The first unit is expected to come on-stream early in 1980, followed by the second unit later the same year, and a third unit in 1983. The plant is designed to supply consumer-owned utilities in an eight-State area with power to meet 1980-84 demands.

Natural Gas.—Marketed natural gas totaled 328.8 billion cubic feet in 1976 compared with 316.1 billion cubic feet in 1975. This is the first year the marketed production has shown an increase since it began declining in 1972. The production showed a 4% increase compared with a 3% decline in 1975. The increased production also reflected an increase in value of 27% compared with a 33% increase in 1975. Wyoming's increase in production was opposite the national trend which showed a 1% decline. On a national basis, Wyoming con-

Table 4.—Wyoming: Bituminous coal production in 1976, by type of mine and county
(Excludes mines producing less than 1,000 short tons annually)

County	Number of mines		Production (thousand short tons)		Value (thousands)
	Under-ground	Surface	Under-ground	Surface	
Campbell -----	--	3	--	W	W
Carbon -----	2	7	W	W	W
Converse -----	--	1	--	W	W
Hot Springs -----	--	1	--	W	W
Lincoln -----	--	2	--	W	W
Sheridan -----	--	2	--	W	W
Sweetwater -----	2	1	W	W	W
Total -----	4	17	524	30,312	\$215,936

W Withheld to avoid disclosing company proprietary data; included in "Total."

tinued its hold on seventh place in production. Production from public land increased to 51.4% in 1976 compared with 50.7% in 1975. Production on all Federal lands was 55.3% in 1976. The major gas-producing counties and their production percentage according to the State Ad Valorem Tax Division were as follows: Sweetwater, 29%; Fremont, 17%; Sublette, 14%; Campbell, 10%; and Lincoln, 6%.

The Brady field, discovered in 1973, replaced Beaver Creek field as the top producer in the State. Production from Brady increased from 7.8 billion cubic feet in 1975 to 20.6 billion cubic feet in 1976, an increase of 164%. Production from the Brady field was 3.5 billion cubic feet in 1974. The Beaver Creek field, which led in production in 1975, produced 18.6 billion cubic feet in 1976, but holds the lead in total production of all active fields with 427.3 trillion cubic feet; only the Salt Creek field has produced more, but it no longer produces. According to the Wyoming Oil and Gas Conservation Commission, the 25 largest fields produced 65% of the State's production in 1976. Three new fields, Big Sand Draw, Birch Creek, and Playa, have replaced Dry Piney, Monell, and Riverton Dome E. among the top 25 producers. Production from the 25 largest fields ranged from 4.0 billion cubic feet to 20.6 billion cubic feet.

The American Gas Association (AGA) reported that Wyoming's natural gas reserves totaled 3.7 trillion cubic feet at yearend 1976 which is the same as in 1975. This indicates that new reserves equaled production for the year.

Natural gas production far exceeds demand in the State. Wyoming consumed 101.5 billion cubic feet of gas during 1976,

up slightly from the 100.4 billion cubic feet used in 1975. Industrial users were the largest users of natural gas, followed by residential and commercial users. Of the total consumption, 63% was for consumer use and the remainder was for extraction loss, and lease, plant and pipeline fuel.

Colorado Interstate Gas Co. (CIG) advised its customers that potential gas production in the Table Rock area of southwest Wyoming could increase deliveries to Colorado customers in late 1976. Two new wells being drilled were scheduled for completion in early November. CIG will increase its peak day natural gas delivery commitment by 11 million cubic feet for the winter heating season.

The move to acquire available supplies of Wyoming natural gas for interstate pipeline continued in southwestern Wyoming. Texas Oil and Gas Co. purchased a 66-mile gas gathering system with a 25-million-cubic-foot-per-day capacity through acquisition of the common stock of Western Transmission, a subsidiary of Acquitaine of Pennsylvania. Initial payment was \$1 million with a deferred payment of \$750,000 due from future gas sales. The purchase also included 30,000 net acres of undeveloped leases of which 14,000 acres are dedicated to CIG. Production from a 9-mile area is being delivered through the system in Carbon and Sweetwater Counties and sold to CIG.

Montana Dakota Utilities (MDU), which draws some of its gas supply from fields in the Worland area, served notice to its industrial users of a 20% cut in gas for the period from midsummer 1976 to midsummer 1977. Apparently these cuts affect operations of the Holly Sugar Corp. plant at Worland and Lovell, oil refineries in Bill-

ings and Laurel, Mont., and other industrial users on the MDU system. Continuing cuts in gas supplies could cause sugar plants to look at coal as an alternative boiler fuel.

Champlin Petroleum Co. tested significant quantities of natural gas in two formations of the Higgins Unit Well No. 1 in the Green River Basin. The Nugget Formation flowed gas at the rate of 6.8 million cubic feet per day, and the deeper Weber Formation flowed gas at 2.2 million cubic feet per day. The company holds a 43.2% interest in the 3,817-acre pooled area where Higgins No. 1 is located and 32% in the 20,211 acres committed to the unit agreement.

Panhandle Eastern Pipe Line Co. has earmarked \$13 million for natural gas exploration in the Green River Basin area. Company officials indicated that additional exploratory work is justified based on past exploration in the area. Previously, 27 wells were drilled with one definite discovery and several promising wells being evaluated. The initial work warrants the new exploration involving 250,000 acres in the Green River Basin.

Cities Service Gas Co. asked the Federal Power Commission to approve its \$95.3 million project to move natural gas from southern Wyoming to an existing pipeline system in Kansas. The project involves 611 miles of pipeline of which 136 miles of new 20-inch line will be laid to reach Rawlins. Anticipated gas supply source is Amoco Production Co. acreage in southern Wyoming, where Cities Service estimates current drilling programs have the potential of adding 5 trillion cubic feet of reserves.

According to the Wyoming Oil and Gas Conservation Commission statistics, there

were 21 gas discoveries in 1976 compared with 9 in 1975. The more significant discoveries were as follows: Echo Springs in Carbon County by Amoco Production Co., Fontenelle in Lincoln County by Chorney Oil Co., Hay Reservoir in Sweetwater County by Davis Oil Co., Ote Creek in Sublette County by Beta Exploration Co., and Yellow Creek in Uinta County by Amoco Production Co. Although Ote Creek and Yellow Creek were adequate discoveries, the big plus for these two fields was that they were in the overthrust belt, thus giving more potential to additional discoveries in the area.

Natural Gas Liquids.—The production of natural gas liquids increased from 9.0 million barrels in 1975 to 9.7 million barrels in 1976. The unit value of the products increased and the total value increased 17%.

The sales of liquified petroleum gases (LPG) and ethane in the State increased 11.8 thousand barrels to 1.62 million barrels. The major uses of these products were as residential and commercial fuel and for internal combustion engines. Residential and commercial use accounted for 71%; the internal combustion engine, 19%; and industrial use, about 7%. Wyoming was a net exporter of LPG and ethane.

Plans for a new \$29 million gas gathering and treatment system was announced by CIG. The plant will be built north of Rock Springs, Sweetwater County, and has a projected capacity of 60 million cubic feet per day. Gas for the plant was discovered in 1975 in the Madison Formation with a tested flow rate of 20 million cubic feet per day from a depth of about 18,000 feet. CIG's new plant will remove the hydrogen sulfide and carbon dioxide. According to

Table 5.—Wyoming: Field production of natural gas, by major field
(Million cubic feet)

Field	County	1975	1976
Brady	Sweetwater	7,761	20,595
Beaver Creek	Fremont	19,902	18,632
Desert Springs	Sweetwater	14,158	13,420
Tip Top	Sublette	11,068	12,140
Hogsback	do	13,254	11,625
Canyon Creek	Sweetwater	9,829	11,004
Madden	Fremont	8,704	10,204
Table Rock	Sweetwater	9,529	10,144
Pavillion	Fremont	8,044	9,047
Elk Basin	Park	11,068	8,736
Other fields		206,516	204,673
Total		319,833	330,220

Source: Wyoming Oil and Gas Conservation Commission.

company officials it has the potential to become a major gas source for its five-State pipeline system. Plans for completion of the plant are set for late 1977.

At yearend, there were 36 operating gas processing plants. Two plants came on-stream during the year and one discontinued operation. The new plants and operators were: Hartzog Draw-Energy West and Thunder Creek-Cities Service Oil Co. During the year, the Boone Dome plant in Natrona County, operated by Terra Resources, Inc., discontinued operations.

According to the AGA, Wyoming's natural gas liquid reserves at yearend 1976 were 61.9 million barrels. This was a 5.2-million-barrel decline from that of 1975.

Petroleum.—Total crude oil production declined slightly to 134.1 million barrels from 135.9 million barrels in 1975. Although this continued the decline in production that started in 1970, the rate of decline is subsided. The decline in 1976 was 1.3% compared with 2.9% in 1975. Major oil-producing counties and their share of production as reported by the State Ad Valorem Tax Division were as follows: Park, 22.5%; Campbell, 22.1%; Sweetwater, 9%; Hot Springs, 8%; Natrona, 7%; and Converse, 6%. These same counties were the six leading producers in 1975 but in 1976 their ranking changed completely. Production from public lands decreased to 57% compared with 58% in 1975. A breakdown of mineral ownership by the Wyoming Oil and Gas Commission follows: All Federal lands, 61%; State lands, 6%; and fee lands, 33%. Although there was a slight decline in production, the unit value of the crude remained the same at \$7.24 per barrel, but was below the national average of \$8.14 per barrel. The State continued to be first in petroleum output in the Rocky Mountain States and fifth nationally.

According to the U.S. Department of Energy report, "Crude Petroleum, Petroleum Products, and Natural Gas Liquids 1976," about 146 million barrels of oil were shipped to refineries, of which 54 million barrels were to refineries in the State and the remaining 92 million barrels were shipped out of State. The crude oil refined in the State was about 400,000 barrels more than in 1975. The State has a refining capacity of 68 million barrels per year and during the year operated at 80% of capacity. Ship-

ments of crude oil east of the Mississippi river were as follows: Indiana, 15.8 million barrels; Illinois, 11.4 million barrels; Michigan, 8.6 million barrels; Ohio, 3.8 million barrels; and Kentucky-Tennessee, 890,000 barrels. Other destinations were as follows: Kansas, 17.9 million barrels; Montana, 17.1 million barrels; Utah, 7.8 million barrels; and Colorado, 7.3 million barrels. A small amount, 1.3 million barrels, was shipped into the State from: Colorado, 1.2 million barrels; Utah, 103,000 barrels; and Montana, 26,000 barrels.

The top 10 fields produced 44% of the State's production in 1976. Three fields from the Big Horn Basin have been replaced by two fields in Sweetwater County and one in Converse County. The Big Horn Basin with 5 of the top 10 fields still contained the majority of the top producing fields.

Wyoming's crude oil reserves at yearend 1976, as estimated by the American Petroleum Institute (API), totaled 827,769,000 barrels down from 877,385,000 in 1975. This was a 6% decline in reserves compared with 3% in 1975, but Wyoming remained sixth in the Nation in reserves.

At yearend, according to the Wyoming Oil and Gas Conservation Commission, the State had 10,027 producing wells, an increase of 950 wells from that of 1975. The average daily production per well was 36.5 barrels, highest in the Nation.

There were 966 exploratory and development wells drilled in 1976, down by 24% from the 1,263 in 1975, according to the API. The total footage drilled was 7 million feet compared with 8.9 million feet in 1975. Of the exploratory wells drilled, 41 were successful oil wells and 22 successful gas wells. Of the development wells drilled, 375 were producing oil wells and 58 producing gas wells. A rotary rig count at yearend was 103 rigs at work, according to Hughes Tool Co. census. Campbell County was the leader in wells drilled with 242 wells and 2.1 million feet of drilling and replaced Converse County, which led in these categories in 1975.

The Powder River Basin was again the most active province in Wyoming with 23 discoveries. The prime objectives in the basin were the Minnelusa, Parkman, and Shannon Formations. Other active areas were the Green River Basin and the Overthrust Belt on the Wyoming-Utah line.

The U.S. Navy awarded a Tulsa, Okla. firm the contract for development of the Naval petroleum reserve at Teapot Dome near Casper, Natrona County. The reserve is estimated to contain 43 million barrels of oil. The Navy's draft environmental impact statement (EIS) for Teapot Dome projected 500 new wells. The EIS said that planned full-scale development will be at a rate that will provide maximum production at an efficient rate. Production is expected to reach 22,000 barrels per day after 2 years of drilling according to Navy officials. According to the EIS, roads, powerlines, pipelines, and other production equipment will have to be built before the reserves are fully developed. Total development costs are projected at \$54 million.

The Civil Engineering Department at the University of Wyoming conducted a research project on wind loads on a derrick at Laramie. Recorded information will be used to determine wind load requirements for derrick guylines. The study may be used to assist in the formulation of new guyline wind load regulations issued by the Wyoming Occupational Health and Safety Administration.

Amoco Production Co. completed its Ryckman Creek discovery well in the Wyoming portion of the Overthrust Belt as a flowing oil well. The discovery well, Champlin 224 Amoco "A" No. 1, was completed, flowing at the rate of 280 barrels of oil and 310,000 cubic feet of gas per day. The Ryckman Creek discovery is about 14 miles northeast of Evanston, on land opened for exploration by a 1969 agreement between Amoco Production and Champlin Petroleum Co., a subsidiary of

Union Pacific Corp. Amoco and Chevron Oil Co. each own 50% of the Ryckman Creek discovery. After payout of the well, ownership will be Amoco, 37.5%; Chevron, 50%; and Champlin, 12.5% on the well and the 2,237-acre drilling pool area. Based on the initial success in the area, the company is continuing an extensive exploratory program in the Overthrust Belt.

Amoco's discovery in the complex Overthrust Belt or disturbed area of southwest Wyoming and nearby Utah has resulted in a lease play that extends into eastern Idaho and western Montana to the Canadian border. The excitement was evidenced by the 11 drilling rigs in Lincoln County, and 5 in Uinta County by mid-July. The primary objective of the exploration is the Nugget sandstone of Jurassic age. Drilling activity in the Overthrust Belt has resulted in three field discoveries, Ote Creek, Ryckman Creek, and Yellow Creek.

Drilling for oil in Laramie County was the most significant in 12 years as 16 wells were drilled with 1 discovery, Chivington field. The discovery occurred in October and two additional wells brought the daily field production to 600 to 700 barrels. All the drilling was done by Amoco.

Union Oil Co. of California completed the region's deepest well, No. 1 Hells Half Acre, as a Frontier gas discovery for 664,000 cubic feet per day from the depth interval 18,510 feet to 18,907 feet. Total depth of the well was 22,431 feet, a record depth for the Rockies. The cost of the well is estimated at \$10 million. Deep drilling was most active in the Rockies in 1976 with most of the deep wells drilled in southwestern Wyoming.

Table 6.—Wyoming: Production of crude petroleum, by major field
(Thousand 42-gallon barrels)

Field	County	1975	1976
Oregon Basin	Park	12,554	12,265
Salt Creek	Natrona	9,838	7,478
Hamilton Dome	Hot Springs	4,623	6,988
Elk Basin	Park	6,825	6,267
Brady ¹	Sweetwater	2,000	5,810
Little Buffalo Basin	Park and Hot Springs	3,971	5,052
Grass Creek	Hot Springs	4,710	3,919
Hilight	Campbell	5,556	3,821
Well Draw ¹	Converse	4,060	3,745
Lost Soldier ¹	Sweetwater	2,763	3,725
Other fields		79,043	75,079
Total		135,943	134,149

¹ These fields have replaced Byron, Frannie, and Garland in top 10.

Source: Wyoming Oil and Gas Conservation Commission.

Table 7.—Wyoming: Principal oil and gas discoveries in 1976

County and field	Operator	Producing formation	Total depth (feet)
CRUDE OIL			
Campbell:			
Breaks -----	Smith-Fancher -----	Minnelusa -----	7,581
Carson West -----	Anschutz Corp -----	Muddy -----	8,007
Mud Spring -----	Reading & Bates -----	Shannon -----	
Pine Tree -----	Woods Petroleum Corp -----	-----do -----	10,420
Twin Creek -----	Universal Resource Corp -----	Minnelusa -----	8,118
Converse:			
Brush Creek -----	Davis Oil Co. and Ladd Petroleum. -----	Parkman -----	8,425
Rat Creek -----	Ladd Petroleum and Petroleum Inc. -----	-----do -----	10,654
Fremont:			
Jade Ridge -----	Kimbark & Hilliard Oil -----	Dakota -----	5,340
Natrona:			
Burnt Wagon -----	Drwenski, Pruet and Hughes Aquitaine. -----	Frontier -----	8,639
Niobrara:			
Young Woman -----	Simasko Production -----	Dakota -----	3,655
Park:			
Cody -----	Husky Oil Co -----	Tensleep -----	7,480
Uinta:			
Ryckman Creek -----	Amoco Production Co -----	Nugget -----	14,795
NATURAL GAS			
Carbon:			
Deep Gulch -----	Exeter Exploration Co -----	Frontier -----	8,551
Echo Springs -----	Amoco Production Co -----	Almond -----	NA
Filmore -----	Davis Oil Co -----	Frontier -----	9,225
Lincoln:			
Black Jack -----	-----do -----	-----do -----	11,985
Sublette:			
Ote Creek -----	Beta Exploration Co -----	Fort Union -----	6,000
Sweetwater:			
Hay Reservoir -----	Davis Oil Co -----	Lewis -----	10,132
Red Lakes -----	Amoco Production Co -----	Almond -----	11,870
Uinta:			
Yellow Creek -----	-----do -----	Phosphoria -----	8,068

NA Not available.

Source: Petroleum Information Corp. 1976 Resume Oil and Gas Operations in the Rocky Mountain Region.

NONMETALS

Cement.—The 1976 production of cement increased about 4% above that of 1975. Monolith Portland Midwest Co. in Laramie continued to be the only cement producer in Wyoming. According to the State Inspector of Mines Annual Report of 1976, the company produced about 200,000 tons of cement. The types of cement shipped were Types I, II, and V, but the majority was Types I and II. Ready-mix companies were the principal recipients of the cement followed by other contractors, concrete products manufacturers, and building material dealers.

Clays.—The production of clays was about 3.7 million tons compared with 2.6 million tons in 1975. The output in 1976 consisted of 2.5 million tons of bentonite and 0.2 million tons of clay and shale. The bentonite production increased about 92,000 tons over the 1975 production. Bentonite was mined by eight companies and four

companies mined clay and shale. The production of bentonite was from Big Horn, Crook, Johnson, Natrona, Washakie, and Weston Counties. Crook County led the State with 34% of the production, followed by Big Horn with 25%, and Weston with 16%. The major production of common clay and shale was again from Albany County. The company which led in bentonite production was Federal Bentonite Co. with about 620,000 tons followed by American Colloid Co. with 610,000 tons according to the State Mine Inspectors report for 1976.

Dresser Industries, Inc., of Greybull was expanding its plant to increase capacity by 50%. The existing mill building contains 6,400 square feet along with the warehouse of 16,000 square feet. The expansion was primarily a result of the everincreasing demand for bentonite drilling mud. The new expansion is expected to be completed by late 1977 or early 1978.

The energy shortage has made bentonite

companies aware of the need to change fuel supplies. Kaycee Bentonite Corp. currently runs both plant furnaces on natural gas but is contemplating switching to coal. The company has already purchased some coal-firing equipment and will be prepared to switch to coal when necessary.

Baroid Division, NL Industries, Inc., increased production over that of 1975. The firm's Colony bentonite plant was expanded slightly over 1975. The company started operating a new plant for producing "Quick-Gel," a trade name for bentonite used as a drilling mud. The new 750-ton-per-day Quick-Gel plant is actually an expansion of Baroid's original plant at Colony.

Feldspar.—Modern Mining and Milling Co., Inc., operated the Quien Sabe mine during the year. The quantity produced increased 43% after declining 38% between 1974 and 1975. The feldspar value showed a dramatic increase of 73% over that of 1975.

Gem Stones.—The estimated value of gem stones production was \$147,000 compared with \$140,000 in 1975. Majestic Jade Co. of Riverton continued to be the only producer of jade in the State.

Gypsum.—Production of crude gypsum increased by 17% over that of 1975. Albany,

Big Horn, and Park Counties were the only counties in which gypsum was produced. Calcined gypsum was produced by The Celotex Corp. and Georgia-Pacific Corp., in Big Horn and Park Counties. Calcined gypsum output increased by 17% over that of 1975.

Lime.—Holly Sugar Corp. and The Great Western Sugar Co. produced lime in Big Horn, Goshen, and Washakie Counties for use in sugar refining. The output of lime increased by 21% over that of 1975.

Phosphate Rock.—Marketed production of phosphate rock continued to decline. The quantity produced was less than that of 1975. The Leefe mine of Stauffer Chemical Co. of Wyoming in Lincoln County was the only producer.

Primary uses for phosphate rock are in making phosphoric acid, normal super phosphate, and triple super phosphate.

Sand and Gravel.—The number of sand and gravel operations remained the same as in 1975 but the output increased 26%. Total value of the sand and gravel increased to \$10.8 million compared with \$10.7 million in 1975 but the unit value decreased. Major uses for the sand and gravel were as concrete aggregate, asphaltic concrete aggregate, and roadbase.

Table 8.—Wyoming: Construction sand and gravel sold or used by producers
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Sand -----	662	2,855	1,528	2,808
Gravel -----	3,404	7,603	3,942	7,978
Sand and gravel -----	261	288	--	--
Total ¹ -----	4,328	10,746	5,470	10,782

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

Table 9.—Wyoming: Construction sand and gravel sold or used, by major use category
(Thousand short tons and thousand dollars)

Use	1975		1976	
	Quantity	Value	Quantity	Value
Concrete aggregate (residential, nonresidential, highways, bridges, dams, waterworks, airports, etc.) -----	1,930	5,319	1,291	3,285
Concrete products (cement blocks, bricks, pipe, etc.) -----	13	55	88	282
Asphaltic concrete aggregates and other bituminous mixtures -----	947	2,772	1,769	3,330
Roadbase and coverings -----	1,133	2,055	1,300	2,090
Fill -----	272	446	432	745
Other uses -----	21	99	590	1,049
Total ¹ -----	4,328	10,746	5,470	10,782

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

Table 10.—Wyoming: Sand and gravel sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976		
	Number of mines	Quantity	Value	Number of mines	Quantity	Value
Albany -----	6	329	569	6	674	1,161
Big Horn -----	4	50	174	4	90	282
Campbell -----	1	W	W	2	W	W
Carbon -----	4	105	376	4	160	513
Converse -----	1	W	W	3	239	487
Crook -----	2	132	W	3	221	315
Fremont -----	11	723	1,376	4	1,073	1,133
Goshen -----	1	W	W	2	W	W
Hot Springs -----	1	6	18	--	--	--
Johnson -----	3	266	690	3	104	244
Laramie -----	6	370	1,045	7	550	1,560
Lincoln -----	1	15	40	1	W	W
Natrona -----	4	647	2,606	6	815	1,633
Park -----	2	W	W	4	328	705
Platte -----	5	547	1,040	2	W	W
Sheridan -----	2	W	W	3	105	254
Sublette -----	1	W	W	4	92	197
Sweetwater -----	4	272	684	4	384	849
Teton -----	3	W	W	5	W	W
Uinta -----	3	W	W	1	38	109
Uinta -----	2	W	W	1	W	W
Washakie -----	5	W	W	1	W	W
Weston -----	2	W	W	2	W	W
Undistributed -----	1	861	2,127	--	592	1,340
Total -----	72	4,328	10,746	71	5,470	10,782

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
 1 Data do not add to total shown because of independent rounding.

Sodium Carbonate.—Wyoming was again the Nation's leading producer of natural sodium carbonate. According to the State Inspector of Mines Report, the State now has four trona mining companies that produced a record 9.5 million tons of trona from which sodium carbonate is recovered. Trona production in 1976 was about 1.4 million tons more than in 1975. Producers according to rank were as follows: FMC Corp., Allied Chemical Corp., Stauffer Chemical Co. of Wyoming, and Texasgulf, Inc. The total sodium carbonate processed from the trona in 1976 rose about 22%.

Texasgulf, Inc., began producing soda ash from its mine in southwestern Wyoming during the year. Site preparation began a little over 3 years ago on the \$150 million project which included a mine and soda ash plant west of Green River. The plant has a design capacity of 1 million tons of soda ash per year. Reserves are in two flat-lying beds at depths of about 1,370 feet to 1,420 feet, and are estimated at 176 million tons of ore. The beds are relatively consistent in thickness and grade and average more than 90% pure trona. This was the first coal-fired soda ash plant built in the State.

FMC Corp. completed its 750,000-ton-per-year expansion of soda ash facilities near Green River. This expansion brings the plant capacity to 2.5 million tons per year. FMC's mine and plant was the first natural soda ash venture in Wyoming. In addition to the expansion, FMC built a new power supply system that gives the plant about 80% energy independence. The new power-plant can use gas, oil, or coal, but it will be fired by coal from FMC's mine near Kemmerer.

The 1976 Environmental Protection Award was presented to FMC Corp. by "Power" magazine. The award is given annually to companies which have been pacesetters in efficient handling of solid waste.

Stauffer is expanding its operations west of Green River. The expansion is expected to increase its annual capacity by 200,000 tons.

Stone.—Stone production decreased to 2.8 million tons in 1976 from 2.9 million tons in 1975. The total value of stone produced in 1976 increased slightly but the unit value increased by 5% to \$2.77 per ton.

Basin Engineering Co., Inc., and the University of Wyoming quarried dimension stone for rubble and rough construction.

Table 11.—Wyoming: Stone sold or used by producers, by county
(Thousand short tons and thousand dollars)

County	1975			1976			Kind of stone produced in 1976
	Number of quarries	Quantity	Value	Number of quarries	Quantity	Value	
Albany -----	6	461	696	4	W	W	Limestone, granite, sandstone.
Campbell -----	--	--	--	1	W	W	Limestone.
Carbon -----	2	49	101	1	W	W	Do.
Crook -----	4	441	645	2	W	W	Do.
Fremont -----	1	40	86	--	--	--	Limestone, granite.
Laramie -----	3	W	W	3	W	W	Various.
Lincoln -----	1	20	36	1	5	10	Dolomite, marble.
Platte -----	2	914	W	2	930	W	Various.
Sublette -----	2	29	51	1	3	7	Various.
Teton -----	2	W	W	2	W	W	Limestone.
Weston -----	3	104	210	2	W	W	Do.
Undistributed ---	--	824	5,792	--	1,818	7,612	
Total ¹ -----	26	2,882	7,618	19	2,757	7,630	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
¹Data may not add to totals shown because of independent rounding.

Output increased 14% to 2,174 tons valued at \$62,500. Sixteen companies crushed stone for railroad ballast, concrete, cement, and other uses. Leading producers were Guernsey Stone Co., Union Pacific Railroad Co., and Peter Kiewit & Sons Co.

Sulfur.—The quantity of sulfur sold or used in 1976 increased by 30% to 51,020 tons. Production of sulfur as a byproduct of sour natural gas, however, continued to decline from 52,000 tons in 1975 to 44,000 tons in 1976. Most of the production of sulfur came from Park, Fremont, and Carbon Counties. Five plants extracted sulfur during 1976.

METALS

Copper.—Amax Incorporated gathered data on drill holes and bulk samples before filing for mining permits for the project at the Kirwin site on the Wood River above Tensleep.

Iron Ore.—Iron ore production increased to 2.1 million long tons in 1976 compared with 2.0 million long tons in 1975.

United States Steel Corp. reported a record shipment of 1,903,000 short tons of taconite pellets in its 14th year of operation.² The taconite was shipped from the U.S. Steel plant about 355 miles to the company's Geneva steel works near Provo, Utah. CF&I Steel Corp. also increased production from 476,378 short tons in 1975 to

491,961 short tons in 1976.³ CF&I ore is shipped from the Sunrise mine to the Pueblo, Colo. steel works.

Uranium.—Wyoming's production of U₃O₈ increased by 18% to 8,064,000 pounds in 1976. The output was 32% of the Nation's total, an increase of 2% over that of 1975, and remained second behind New Mexico.

Kerr-McGee Nuclear Corp. announced the largest sales contract in its history, a contract it said could exceed \$1 billion. The contract with Public Service Electric & Gas Co. of New Jersey calls for delivery of 20 million pounds of yellow cake between 1980-95. The uranium will be mined from the South Powder River Basin where the company has 125,000 acres of uranium mining rights. The project as planned will require the opening of three underground and several open pit mines and construction of a uranium ore processing facility. Initial production will come from the Bill Smith mine presently under construction.

Getty Oil Co. and representatives of 14 electric utility companies in Wisconsin and New England signed a 5-year uranium production sales agreement. The contract, which extends from late 1977 through 1982, provides for the sale of Getty's net share

² Skillings' Mining Review. U.S. Steel Shipments From Atlantic City. V. 66, No. 9, Feb. 26, 1977, p. 8.

³ Skillings' Mining Review. CF&I Iron Ore Shipments in 1976 From Two Mines. V. 66, No. 12, March 1977, p. 8.

of uranium concentrates produced in the Shirley Basin. The agreement provides for a minimum sale of 800,000 pounds to a maximum of 1.2 million pounds of uranium concentrate throughout the terms of the contract.

Utah International Inc. filed an application with the State of Wyoming to open the new Green Mountain uranium mine 15 miles southeast of Jeffrey City. A series of nine uranium pits are planned, with mining to start on the west portion of the property. The nine pits will require the removal of about 100 million yards of earth by 1987.

Plans were announced by RME, a wholly owned subsidiary of Union Pacific Corp., for construction of a multimillion dollar uranium mine-mill complex at Bear Creek, 65 miles northeast of Casper. The project is a joint venture between RME and Mono Power Co., a subsidiary of Southern California Edison Co. The two companies are equal partners in the project; RME will be the operator. Southern California Edison and San Diego Gas and Electric Co. will contract for the mill's entire uranium production. Construction of the 1,000-ton-per-day mill began in the summer of 1976 with startup expected in mid-to-late 1977. Based upon ore reserves now owned or leased by the companies, the mine and mill are expected to operate at least 12 years. The mine will be an open pit operation with land reclamation progressing along with the mining operations.

Officials of the Union Oil Co. of California and its subsidiary, Mineral Exploration Co., announced plans to develop and op-

erate a \$45 million uranium mine and mill in Sweetwater County. Reserves are estimated at 15 million pounds of uranium oxide. The mill will be located 34 air miles northwest of Rawlins. Mine preparation and mill construction will begin in mid-1977 with operation to start in 1978. The mill is expected to operate for 15 years.

Wyoming Minerals Corp. planned to construct a facility to solution mine uranium on the Irigaray property about 40 miles southeast of Buffalo in northeast Wyoming. At full production, the plant is expected to produce about 500,000 pounds of uranium oxide per year by solution mining. This closed-cycle process injects a nontoxic leaching solution into the ore-bearing zone and pumps the uranium-bearing solution to the surface for processing. Construction has begun, with the plant to be operational in 1978. Wyoming Minerals is currently operating a test facility under a permit to explore issued by the Wyoming Department of Environmental Quality.

Florida Power and Light Co. paid \$3 million to American Nuclear Corp. as advance payment for uranium which will be produced from properties in the Gas Hills area. The payment started further intensive development drilling on the Peach claims in the central Gas Hills. Drilling indicated ore trends which extend south from the adjacent Lucky Mc mine of Utah International. Under the agreement, Florida Power will purchase 5 million pounds of uranium oxide with the first million pounds expected to be delivered in 1980 or 1981.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Cement: Monolith Portland Midwest Co. ¹	3326 San Fernando Rd. Los Angeles, Calif. 90065	Plant -----	Albany.
Clays: American Colloid Co -----	5100 Suffield Ct. Skokie, Ill. 60076	Pits and plants ---	Big Horn, Crook, Weston.
Dresser Industries, Inc ----	Box 6504 Houston, Tex. 77005	----do -----	Big Horn.
Federal Bentonite Co -----	4614 Prospect Ave. Cleveland, Ohio 44103	----do -----	Crook and Weston.
International Minerals & Chemical Corp.	5401 Old Orchard Rd. Skokie, Ill. 60076	----do -----	Crook.
Kaycee Bentonite Corp ----	Box 9 Mills, Wyo. 82644	----do -----	Johnson, Natrona, Washakie.
NL Industries, Inc -----	Box 1675 Houston, Tex. 77001	----do -----	Crook and Weston.
Wyo-Ben Products, Inc ----	Box 1979 Billings, Mont. 59103	----do -----	Big Horn.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Coal, bituminous:			
Amax Coal Co -----	Box 1880 Gillette, Wyo. 82716	Strip mine -----	Campbell.
Arch Minerals Corp -----	Box 459 Hanna, Wyo. 82327	Strip mines -----	Carbon.
Big Horn Coal Co -----	Box 724 Sheridan, Wyo. 82801	----do -----	Sheridan.
Bridger Coal Co -----	Box 2068 Rock Springs, Wyo. 82901	----do -----	Sweetwater.
Cordero Mining Co -----	Box 1449 Gillette, Wyo. 82716	----do -----	Campbell.
Kemmerer Coal Co -----	Frontier, Wyo. 83121	Strip mines and plant.	Lincoln.
Pacific Power & Light Co -	920 SW. 6th Ave. Portland, Oreg. 97204	Strip mines -----	Converse.
Rosebud Coal Sales Co ----	Box 398 Hanna, Wyo. 82327	----do -----	Carbon.
Gypsum:			
The Celotex Corp -----	1500 North Dale Mabry Tampa, Fla. 33607	Surface mine and plant.	Park.
Georgia-Pacific Corp -----	900 SW. 5th Ave. Portland, Oreg. 97204	----do -----	Big Horn.
Wyoming Construction Co. ²	Box 907 Laramie, Wyo. 82070	Surface mine -----	Albany.
Iron ore:			
CF&I Steel Corp -----	Box 316 Pueblo, Colo. 81002	Underground mine and plant.	Platte.
United States Steel Corp --	Lander, Wyo. 82520	Open pit mine and plant.	Fremont.
Lime:			
The Great Western Sugar Co. ³	Box 5308 Denver, Colo. 80217	Plant -----	Big Horn.
Holly Sugar Corp -----	Holly Sugar Bldg. Colorado Springs, Colo. 80902	----do -----	Washakie.
Natural gas and petroleum:³			
Phosphate rock:			
Stauffer Chemical Co. of Wyoming. ⁴	636 California St. San Francisco, Calif. 94108	Open pit mine and plant.	Lincoln.
Sand and gravel:			
Gilpatrick Construction Co., Inc.	Box 973 Riverton, Wyo. 82501	Pit -----	Sublette.
Peter Kiewit & Sons Co ---	Box 1009 Sheridan, Wyo. 82801	Pits -----	Natrona and Sweetwater.
Rissler-McMurry Co., Inc --	Box 2499 Casper, Wyo. 82602	----do -----	Carbon, Fremont, Natrona.
Teton Construction Co ----	Box 3243 Cheyenne, Wyo. 82001	Pit -----	Laramie.
Sodium carbonate:			
Allied Chemical Corp -----	Box 70 Morristown, N.J. 07960	Underground mine and plant.	Sweetwater.
FMC Corp -----	Box 872 Green River, Wyo. 82935	----do -----	Do.
Stauffer Chemical Co. of Wyoming.	Box 513 Green River, Wyo. 82935	Strip mine -----	Do.
Texasgulf, Inc -----	Box 100 Granger, Wyo. 82934	----do -----	Do.
Stone:			
Guernsey Stone Co -----	Box 337 Guernsey, Wyo. 82214	Quarry -----	Platte.
Union Pacific Railroad Co -	1416 Dodge St. Omaha, Nebr. 68102	----do -----	Laramie.
Uranium:			
Exxon Minerals Co. U.S.A -	Box 2654 Casper, Wyo. 82602	Open pit mine, un- derground mine, mill.	Converse.
Lucky Mc Uranium Corp --	Box 831 Riverton, Wyo. 82510	----do -----	Carbon and Fremont.
Union Carbide Corp -----	Box 5100 Riverton, Wyo. 82501	Open pit mine and plant.	Fremont and Natrona.

¹ Also clays.² Also stone.³ Most major oil and gas companies and many smaller companies operate in Wyoming and are listed in several commercial directories.⁴ Also sodium carbonate.