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# Minerals Yearbook

1986

*Volume II*

AREA REPORTS: DOMESTIC



*Prepared by staff of the*

BUREAU OF MINES

**UNITED STATES DEPARTMENT OF THE INTERIOR • Donald Paul Hodel, Secretary**

**BUREAU OF MINES • T S Ary, Director**

**As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.**

**U.S. GOVERNMENT PRINTING OFFICE**

**WASHINGTON : 1988**

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# Foreword

This edition of the Minerals Yearbook discusses the performance of the worldwide minerals industry during 1986 and provides background information to assist in interpreting developments during the year being reviewed. Content of the individual volumes follows:

Volume I, *Metals and Minerals*, contains chapters on virtually all metallic and industrial mineral commodities important to the U.S. economy. In addition, it includes a statistical summary chapter, a chapter on mining and quarrying trends, and a chapter discussing the statistical surveying methods used by the Bureau of Mines.

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.

Volume III, *Area Reports: International*, contains the latest available mineral data on more than 150 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 users. Therefore, constructive comments and suggestions by readers of the Yearbook will be welcomed.

T S Ary, *Director*



# Acknowledgments

The chapters of this volume were written by the State Mineral Officers of the Bureau of Mines, located throughout the country. Preparation of the chapters was coordinated by the Office of State Activities, Division of Mineral Commodities, which also prepared the table of economic indicators.

The Statistical Summary chapter and the tabular material covering total State mineral production and mineral production by county, were prepared in the Division of Mineral Commodities. The Office of Special Projects reviewed the manuscripts upon which this volume was based to ensure 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 statistics and other data provided by the mineral industries. The Bureau gratefully acknowledges the willing contribution of these essential data by both companies and individuals.

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

Alabama: Geological Survey of Alabama.

Alaska: Division of Geological and Geophysical Surveys, Alaska Department of Natural Resources.

Arizona: Arizona Department of Mines and Mineral Resources.

Arkansas: Arkansas Geological Commission.

California: California Department of Conservation, Division of Mines and Geology.

Colorado: Colorado Geological Survey.

Connecticut: State Geological and Natural History Survey of Connecticut, Department of Environmental Protection.

Delaware: Delaware Geological Survey.

Florida: Florida Bureau of Geology.

Georgia: Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.

Hawaii: Department of Land and Natural Resources.

Idaho: Idaho Geological Survey, University of Idaho.

Illinois: State Geological Survey Division, Illinois Department of Energy and Natural Resources.

Indiana: Geological Survey, Indiana Department of Natural Resources.

Iowa: Iowa Energy and Geological Resources Division, Iowa Department of Natural Resources.

Kansas: Kansas Geological Survey.

Kentucky: Kentucky Geological Survey.

Louisiana: Louisiana Geological Survey.

Maine: Maine Geological Survey.

Maryland: Maryland Geological Survey.

Massachusetts: Commonwealth of Massachusetts, Executive Office of Environmental Affairs.

Michigan: Geological Survey Division, Michigan Department of Natural Resources.

Minnesota: Mineral Resources Research Center, University of Minnesota.

Mississippi: Bureau of Geology and Energy Resources, Mississippi Department of Natural Resources.

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

Donald S. Colby, *Chief, Office of State Activities*

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# Statistical Summary

By Stephen D. Smith<sup>1</sup>

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

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is 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 output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics

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

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

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<sup>1</sup>Mineral data assistant, Division of Ferrous Metals. The author was assisted in preparation of this chapter by Barbara M. Carrico, Chief, Branch of Nonferrous Metals Data; Sarah P. Guerrino, Chief, Branch of Ferrous Metals Data; Barbara E. Gunn, Chief, Branch of Industrial Minerals Data; William L. Zajac, Chief, Branch of Geographic Data.

Table 1.—Nonfuel mineral production<sup>1</sup> in the United States

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>METALS</b>						
Antimony (content of ore and concentrate) ----- short tons .....	557	W	W	W	W	W
Bauxite ----- thousand metric tons, dried equivalent .....	856	\$15,643	674	\$12,855	510	\$10,366
Copper (recoverable content of ores, etc.) ----- metric tons .....	1,102,613	1,625,116	1,105,758	1,632,483	1,147,277	1,670,660
Gold (recoverable content of ores, etc.) ----- troy ounces .....	2,084,615	751,833	<sup>r</sup> 2,427,232	<sup>r</sup> 771,032	3,733,190	1,374,710
Iron oxide pigments, crude ----- short tons .....	53,017	2,819	46,585	2,826	40,987	2,908
Lead (recoverable content of ores, etc.) ----- metric tons .....	322,677	181,745	413,955	174,008	339,793	165,150
Magnesium metal <sup>2</sup> ----- short tons .....	---	---	---	---	138,493	423,788
Manganiferous ore (5% to 35% Mn) ----- short tons, gross weight .....	88,423	860	19,882	W	14,320	W
Mercury ----- 76-pound flasks .....	19,048	W	16,530	W	W	W
Molybdenum (content of ore and concentrate) ----- thousand pounds .....	102,405	326,780	111,936	347,812	95,006	240,484
Nickel (content of ore and concentrate) ----- short tons .....	14,540	W	6,127	W	1,175	W
Silver (recoverable content of ores, etc.) ----- thousand troy ounces .....	44,592	363,006	<sup>r</sup> 39,433	<sup>r</sup> 242,205	34,220	187,183
Tungsten (content of ore and concentrate) ----- metric tons .....	1,173	13,409	983	9,143	817	5,774
Vanadium (content of ore and concentrate) ----- short tons .....	1,617	24,551	W	W	W	W
Zinc (recoverable content of ores, etc.) ----- metric tons .....	252,768	270,833	226,545	201,607	202,983	170,050
Combined value of beryllium concentrate, iron ore (usable), magnesium chloride for magnesium metal (1984-85), <sup>3</sup> rare-earth metal concentrates, tin, titanium concentrates (ilmenite and rutile), zircon concentrate, and values indicated by symbol W -----	XX	2,427,624	XX	<sup>r</sup> 2,234,916	XX	1,562,607
Total <sup>4</sup> -----	XX	6,004,000	XX	<sup>r</sup> 5,629,000	XX	5,814,000
<b>INDUSTRIAL MINERALS (EXCEPT FUELS)</b>						
Abrasive stones <sup>5</sup> ----- short tons .....	1,290	602	1,157	515	W	W
Asbestos ----- metric tons .....	57,422	24,238	57,457	20,485	51,437	17,367
Barite ----- thousand short tons .....	775	25,445	739	21,501	297	12,326
Boron minerals ----- do. ....	1,367	456,687	1,269	404,775	1,251	426,086
Bromine ----- thousand pounds .....	385,000	95,000	320,000	80,000	310,000	93,000
Calcium chloride (natural) ----- short tons .....	<sup>e</sup> 838,000	<sup>e</sup> 93,000	W	W	W	W
Cement: Masonry ----- thousand short tons .....	3,281	219,877	3,187	213,096	3,525	231,551
Portland ----- do. ....	74,376	3,810,446	74,250	3,817,335	75,181	3,759,942
Clays ----- do. ....	43,702	1,032,127	44,974	1,011,377	44,620	1,095,179
Diatomite ----- do. ....	627	120,926	635	127,030	628	128,362
Emery ----- short tons .....	W	W	W	W	2,878	W
Feldspar ----- do. ....	710,000	23,500	700,000	22,800	735,000	26,100
Fluorspar ----- do. ....	<sup>r</sup> 72,000	W	66,000	W	<sup>r</sup> 78,000	W
Garnet (abrasive) ----- do. ....	29,647	<sup>e</sup> 2,487	36,727	2,973	32,296	2,603
Gem stones ----- NA .....	NA	<sup>e</sup> 7,450	NA	<sup>e</sup> 7,425	NA	9,247
Gypsum ----- thousand short tons .....	14,319	113,671	14,726	114,229	15,789	102,047
Helium: Crude ----- million cubic feet .....	W	W	W	W	492	9,504
Grade-A ----- do. ....	1,642	61,575	1,865	69,938	1,941	72,783
Lime ----- thousand short tons .....	15,922	811,183	15,690	809,000	14,474	757,867
Mica (scrap) ----- do. ....	161	7,139	138	6,330	148	7,108
Peat ----- do. ....	814	19,907	882	21,892	1,012	23,560
Perlite ----- do. ....	498	16,638	507	17,160	507	15,646
Phosphate rock ----- thousand metric tons .....	49,197	1,182,244	50,835	<sup>r</sup> 1,236,000	38,710	878,000
Potassium salts (K <sub>2</sub> O equivalent) ----- do. ....	1,639	241,800	1,266	178,400	1,147	152,000
Pumice ----- thousand short tons .....	502	4,929	508	4,553	554	5,756
Salt ----- do. ....	39,225	675,099	<sup>r</sup> 40,067	<sup>r</sup> 739,609	36,663	665,400
Sand and gravel: Construction ----- do. ....	773,900	2,244,000	<sup>e</sup> 800,100	<sup>e</sup> 2,438,000	883,000	2,747,200
Industrial ----- do. ....	29,380	377,200	29,430	374,070	27,420	359,300
Sodium sulfate (natural) ----- do. ....	435	40,125	389	35,360	396	34,102
Stone: <sup>6</sup> Crushed ----- do. ....	<sup>e</sup> 956,000	<sup>e</sup> 3,755,600	1,000,800	4,053,000	<sup>e</sup> 1,023,200	<sup>e</sup> 4,255,000
Dimension ----- do. ....	<sup>r</sup> 1,141	<sup>r</sup> 161,912	<sup>r</sup> 1,104	<sup>r</sup> 172,435	<sup>e</sup> 1,163	<sup>e</sup> 173,269

See footnotes at end of table.

Table 1.—Nonfuel mineral production<sup>1</sup> in the United States —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>INDUSTRIAL MINERALS (EXCEPT FUELS) —Continued</b>						
Sulfur (Frasch) thousand metric tons...	5,001	\$546,106	4,678	\$573,570	4,180	\$508,512
Talc and pyrophyllite thousand short tons...	1,127	23,167	1,269	29,188	1,302	31,227
Tripoli..... short tons...	124,482	699	W	W	117,174	918
Vermiculite... thousand short tons...	315	31,500	314	32,400	317	34,400
Combined value of aplite, asphalt (native), graphite (1984), iodine, kyanite, lithium minerals, magnesite, magnesium compounds, <sup>7</sup> marl (greensand), olivine, pyrites, sodium carbonate (natural), staurolite, wollastonite, and values indicated by symbol W.....	XX	937,900	XX	<sup>†</sup> 1,046,003	XX	1,003,162
Total <sup>4</sup> .....	XX	<sup>†</sup> 17,164,000	XX	<sup>†</sup> 17,681,000	XX	17,639,000
Grand total <sup>4</sup> .....	XX	<sup>†</sup> 23,168,000	XX	<sup>†</sup> 23,309,000	XX	23,452,000

<sup>1</sup>Estimated. <sup>2</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

<sup>3</sup>Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

<sup>4</sup>Magnesium metal (refinery production) not reported in 1984 and 1985.

<sup>5</sup>Magnesium chloride for magnesium metal reporting discontinued in 1986.

<sup>6</sup>Data may not add to totals shown because of independent rounding.

<sup>7</sup>Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

<sup>8</sup>Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.

<sup>9</sup>Excludes values that must be concealed to avoid disclosing company proprietary data.

**Table 2.—Nonfuel minerals produced in the United States and principal producing States in 1986**

Mineral	Principal producing States, in order of quantity	Other producing States
Abrasives <sup>1</sup>	AR, WI, IN, OH.	
Antimony (content of ore, etc.)	ID.	
Aplite	VA.	
Asbestos	CA and VT.	
Asphalt (native)	TX and UT.	
Barite	NV, GA, MO, TN.	
Bauxite	AR and AL.	
Beryllium concentrate	UT, SD, WY.	
Boron minerals	CA.	
Bromine	AR and MI.	
Calcium chloride (natural)	MI, CA, WA.	
Cement	CA, TX, PA, MI	All other States except CT, DE, MA, MN, NH, NJ, NC, ND, RI, VT.
Clays	GA, OH, NC, TX	All other States except AK, DE, HI, RI, VT, WI.
Copper (content of ores, etc.)	AZ, NM, MI, MT	CA, CO, ID, IL, MO, NV, TN, UT.
Diatomite	CA, NV, WA, OR.	
Emery	NY.	
Feldspar	NC, CT, GA, CA	OK, SD.
Fluorspar	IL, NV, TX.	
Garnet (abrasive)	ID, NY, ME.	
Gold (content of ores, etc.)	NV, CA, SD, MT	AK, AZ, CO, ID, MI, NM, NC, OR, SC, UT, WA.
Gypsum	TX, MI, IA, OK	AR, AZ, CA, CO, IN, KS, MT, NV, NM, NY, OH, SD, UT, VA, WA, WY.
Helium	KS, TX, WY, NM.	
Iodine	OK.	
Iron ore (usable)	MN, MI, MO, UT	CA, MT, NV, NM, TX.
Iron oxide pigments (crude)	MI, GA, MO, VA.	
Kyanite	VA and GA.	
Lead (content of ores, etc.)	MO, ID, CO, MT	AZ, IL, NY, NM.
Lime	OH, MO, PA, KY	All other States except AK, CT, DE, GA, KS, ME, MS, NH, NJ, NM, NC, RI, SC, VT, WV.
Lithium minerals	NC and NV.	
Magnesite	NV.	
Magnesium compounds	MI, CA, UT, TX	DE.
Magnesium metal	TX, WA, UT.	
Manganiferous ore	SC.	
Marl (greensand)	DE and NJ.	
Mercury	NV.	
Mica (scrap)	NC, SD, SC, NM	CT, GA, PA.
Molybdenum	CO, AZ, ID, NM	CA, MT.
Nickel	OR.	
Olivine	NC and WA.	
Peat	FL, MI, IN, IL	CA, CO, GA, IA, MA, MD, ME, MN, MT, NC, NJ, NY, ND, OH, PA, SC, WA, WI.
Perlite	NM, AZ, CA, NV	CO, ID.
Phosphate rock	FL, NC, ID, TN	MT, UT.
Potassium salts	NM, CA, UT.	
Pumice	NM, OR, CA, ID	AZ, HI, KS, OK.
Pyrites (ore and concentrate)	TN.	
Rare-earth metal concentrates	CA and FL.	
Salt	LA, TX, NY, OH	AL, AZ, CA, KS, MI, NM, NV, ND, OK, UT, WV.
Sand and gravel:		
Construction	CA, TX, MI, AZ	All other States.
Industrial	IL, MI, CA, NJ	All other States except AK, DE, HI, IA, ME, NH, NM, OR, SD, VT, WY.
Silver (content of ores, etc.)	ID, NV, MT, AZ	AK, CA, CO, IL, MI, MO, NM, NY, SC, SD, TN, UT, WA.
Sodium carbonate (natural)	WY and CA.	
Sodium sulfate (natural)	CA, TX, UT.	
Staurolite	FL.	
Stone:		
Crushed	TX, FL, PA, GA	All other States except DE.
Dimension	GA, IN, VT, NH	All other States except AK, DE, FL, HI, KY, LA, MS, NE, NV, NJ, ND, RI, WV, WY.
Sulfur (Frasch)	TX and LA.	
Talc and pyrophyllite	MT, TX, VT, NY	AR, CA, GA, NC, OR.
Tin	AK.	
Titanium concentrates	FL.	
Tripoli	IL, OK, AR, PA.	
Tungsten (content of ore, etc.)	CA and CO.	
Vanadium (content of ore, etc.)	ID, CO, UT.	
Vermiculite (crude)	MT, SC, VA, UT.	
Wollastonite	NY and CA.	
Zinc (content of ores, etc.)	TN, NY, MO, CO	ID, IL, NJ.
Zircon concentrate	FL.	

<sup>1</sup>Grindstones, pulpstones, and sharpening stones; excludes mill liners and grinding pebbles.

Table 3.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1986

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	\$405,216	19	1.73	Cement (portland), stone (crushed), lime, sand and gravel (construction).
Alaska	91,480	42	.39	Sand and gravel (construction), gold, stone (crushed), cement (portland).
Arizona	1,556,085	3	6.63	Copper, sand and gravel (construction), cement (portland), molybdenum.
Arkansas	263,007	29	1.12	Bromine, stone (crushed), cement (portland), sand and gravel (construction).
California	2,269,417	1	9.68	Cement (portland), sand and gravel (construction), boron minerals, stone (crushed).
Colorado	370,008	23	1.58	Molybdenum, cement (portland), sand and gravel (construction), gold.
Connecticut	80,454	43	.34	Stone (crushed), sand and gravel (construction), feldspar, sand and gravel (industrial).
Delaware	4,169	50	.02	Magnesium compounds, sand and gravel (construction), marl (greensand), gem stones.
Florida	1,295,153	4	5.52	Phosphate rock, stone (crushed), cement (portland), sand and gravel (construction).
Georgia	1,091,455	7	4.65	Clays, stone (crushed), cement (portland), sand and gravel (construction).
Hawaii	70,412	44	.30	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Idaho	246,716	32	1.05	Silver, phosphate rock, molybdenum, gold.
Illinois	469,525	16	2.00	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial).
Indiana	305,348	26	1.30	Cement (portland), stone (crushed), sand and gravel (construction), cement (masonry).
Iowa	248,732	30	1.06	Stone (crushed), cement (portland), sand and gravel (construction), gypsum (crude).
Kansas	317,645	24	1.35	Cement (portland), salt, stone (crushed), helium (Grade-A).
Kentucky	267,265	28	1.14	Stone (crushed), lime, cement (portland), sand and gravel (construction).
Louisiana	446,798	18	1.91	Sulfur (Frasch), salt, sand and gravel (construction), stone (crushed).
Maine	52,859	46	.23	Cement (portland), sand and gravel (construction), stone (crushed), cement (masonry).
Maryland	313,345	25	1.34	Stone (crushed), cement (portland), sand and gravel (construction), cement (masonry).
Massachusetts	134,397	37	.57	Sand and gravel (construction), stone (crushed), stone (dimension), lime.
Michigan	1,252,850	5	5.34	Iron ore (usable), cement (portland), calcium chloride (natural), magnesium compounds.
Minnesota	1,127,627	6	4.81	Iron ore (usable), sand and gravel (construction), stone (crushed), stone (dimension).
Mississippi	101,095	40	.43	Sand and gravel (construction), clays, cement (portland), stone (crushed).
Missouri	748,585	10	3.19	Cement (portland), stone (crushed), lead, lime.
Montana	236,960	33	1.01	Gold, copper, silver, cement (portland).
Nebraska	94,088	41	.40	Cement (portland), sand and gravel (construction), stone (crushed), lime.
Nevada	977,331	8	4.17	Gold, sand and gravel (construction), cement (portland), silver.
New Hampshire	38,577	47	.16	Sand and gravel (construction), stone (crushed), stone (dimension), clays.
New Jersey	186,248	35	.79	Stone (crushed), sand and gravel (construction), sand and gravel (industrial), zinc.
New Mexico	612,075	12	2.61	Copper, potassium salts, sand and gravel (construction), cement (portland).
New York	677,562	11	2.89	Stone (crushed), cement (portland), salt, sand and gravel (construction).
North Carolina	466,423	17	1.99	Stone (crushed), phosphate rock, lithium minerals, sand and gravel (construction).
North Dakota	20,802	48	.09	Sand and gravel (construction), lime, salt, clays.
Ohio	609,984	13	2.60	Stone (crushed), salt, sand and gravel (construction), lime.
Oklahoma	247,015	31	1.05	Stone (crushed), cement (portland), sand and gravel (construction), sand and gravel (industrial).
Oregon	126,432	39	.54	Stone (crushed), sand and gravel (construction), cement (portland), lime.
Pennsylvania	843,058	9	3.59	Cement (portland), stone (crushed), lime, sand and gravel (construction).
Rhode Island	14,196	49	.06	Sand and gravel (construction), stone (crushed), sand and gravel (industrial), gem stones.
South Carolina	295,889	27	1.26	Cement (portland), stone (crushed), clays, sand and gravel (construction).
South Dakota	232,886	34	.99	Gold, cement (portland), sand and gravel (construction), stone (dimension).
Tennessee	481,656	15	2.05	Stone (crushed), zinc, cement (portland), pyrites.
Texas	1,711,988	2	7.30	Cement (portland), stone (crushed), sulfur (Frasch), magnesium metal.
Utah	374,056	22	1.59	Magnesium metal, cement (portland), gold, sand and gravel (construction).
Vermont	55,211	45	.24	Stone (dimension), sand and gravel (construction), stone (crushed), talc and pyrophyllite.

See footnote at end of table.

**Table 3.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1986 —Continued**

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Virginia -----	\$393,037	20	1.68	Stone (crushed), cement (portland), sand and gravel (construction), lime.
Washington -----	376,625	21	1.61	Magnesium metal, sand and gravel (construction), gold, cement (portland).
West Virginia ----	129,809	38	.55	Cement (portland), stone (crushed), salt, sand and gravel (industrial).
Wisconsin -----	164,532	36	.70	Sand and gravel (construction), stone (crushed), lime, sand and gravel (industrial).
Wyoming -----	556,094	14	2.37	Sodium carbonate (natural), clays, sand and gravel (construction), cement (portland).
Total <sup>2</sup> -----	23,452,000	XX	100.00	

XX Not applicable.

<sup>1</sup>Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.<sup>2</sup>Data may not add to totals shown because of independent rounding.**Table 4.—Value of nonfuel mineral production per capita and per square mile in 1986, by State**

State	Area (square miles)	Population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama -----	51,705	4,053	\$405,216	7,837	25	100	21
Alaska -----	591,004	534	91,480	155	50	171	11
Arizona -----	114,000	3,317	1,556,035	13,649	12	469	3
Arkansas -----	53,187	2,372	263,007	4,945	33	111	17
California -----	158,706	26,981	2,269,417	14,300	10	84	26
Colorado -----	104,091	3,267	370,008	3,555	38	113	15
Connecticut -----	5,018	3,189	80,454	16,033	8	25	46
Delaware -----	2,044	633	4,169	2,040	44	7	50
Florida -----	58,664	11,675	1,236,153	22,077	3	111	16
Georgia -----	58,910	6,104	1,091,455	18,527	6	179	10
Hawaii -----	6,471	1,062	70,412	10,881	16	66	34
Idaho -----	83,564	1,003	246,716	2,952	41	246	8
Illinois -----	56,345	11,553	469,525	8,333	24	41	40
Indiana -----	36,185	5,504	305,348	8,439	23	55	37
Iowa -----	56,275	2,851	248,732	4,420	34	87	24
Kansas -----	82,277	2,461	317,645	3,861	37	129	14
Kentucky -----	40,409	3,728	267,265	6,614	26	72	29
Louisiana -----	47,751	4,501	446,798	9,857	20	99	22
Maine -----	33,265	1,174	52,859	1,589	46	45	39
Maryland -----	10,460	4,463	313,345	29,957	1	70	31
Massachusetts -----	8,284	5,832	134,397	16,224	7	23	48
Michigan -----	58,527	9,145	1,252,850	21,406	4	137	13
Minnesota -----	84,402	4,214	1,127,627	13,360	13	268	7
Mississippi -----	47,689	2,625	101,095	2,120	43	39	41
Missouri -----	69,697	5,066	748,585	10,741	17	148	12
Montana -----	147,046	819	236,960	1,611	45	289	6
Nebraska -----	77,355	1,598	94,088	1,216	48	59	35
Nevada -----	110,561	963	977,331	8,840	22	1,015	2
New Hampshire -----	9,279	1,027	38,577	4,157	36	38	43
New Jersey -----	7,787	7,620	186,248	23,918	2	24	47
New Mexico -----	121,593	1,479	612,075	5,034	32	414	4
New York -----	49,107	17,772	677,562	13,798	11	38	42
North Carolina -----	52,669	6,331	466,423	8,856	21	74	28
North Dakota -----	70,703	679	20,802	294	49	31	45
Ohio -----	41,330	10,752	609,984	14,759	9	57	36
Oklahoma -----	69,956	3,305	247,015	3,531	39	75	27
Oregon -----	97,073	2,698	126,432	1,302	47	47	38
Pennsylvania -----	45,308	11,839	843,058	13,607	5	71	30
Rhode Island -----	1,212	975	14,196	11,713	14	15	49
South Carolina -----	31,113	3,378	235,889	9,510	19	88	23
South Dakota -----	77,116	708	232,886	3,020	40	329	5
Tennessee -----	42,144	4,803	481,656	11,429	15	100	20
Texas -----	266,807	16,682	1,711,988	6,417	27	103	18
Utah -----	84,899	1,665	374,056	4,406	35	225	9
Vermont -----	9,614	541	55,211	5,743	28	102	19

See footnotes at end of table.

Table 4.—Value of nonfuel mineral production per capita and per square mile in 1986, by State—Continued

State	Area (square miles)	Population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Virginia -----	40,767	5,787	\$393,037	9,641	18	68	32
Washington -----	68,138	4,463	376,625	5,527	30	84	25
West Virginia -----	24,231	1,919	129,809	5,357	31	68	33
Wisconsin -----	56,153	4,785	164,532	2,930	42	34	44
Wyoming -----	97,809	507	556,094	5,685	29	1,097	1
Total <sup>2</sup> or average -----	3,618,700	240,452	\$23,452,000	6,481	XX	98	XX

XX Not applicable.

<sup>1</sup>Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

<sup>2</sup>Excludes Washington, DC (which has no mineral production), with an area of 69 square miles and a population of 626,000.

<sup>3</sup>Data do not add to total shown because of independent rounding.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA						
Cement:						
Masonry ----- thousand short tons ..	259	\$17,247	268	\$18,113	267	\$18,165
Portland ----- do. ....	3,656	167,191	3,721	165,972	3,477	153,629
Clays <sup>2</sup> ----- do. ....	1,906	30,500	1,873	13,139	2,077	14,828
Gem stones ----- do. ....	NA	<sup>e</sup> 1	NA	<sup>f</sup> 1	NA	1
Lime ----- thousand short tons ..	1,163	50,560	1,216	52,295	1,180	50,377
Sand and gravel:						
Construction ----- do. ....	10,348	26,188	<sup>e</sup> 11,000	<sup>e</sup> 32,000	10,781	30,807
Industrial ----- do. ....	442	3,600	524	4,533	433	3,388
Stone:						
Crushed ----- do. ....	<sup>e</sup> 22,000	<sup>e</sup> 98,500	25,853	109,176	<sup>e</sup> 24,000	<sup>e</sup> 120,500
Dimension ----- do. ....	<sup>r</sup> <sup>e</sup> 9	<sup>r</sup> <sup>e</sup> 2,231	<sup>r</sup> 10	<sup>r</sup> 2,661	<sup>e</sup> 8	<sup>e</sup> 968
Combined value of bauxite, clays (bentonite), and salt -----	XX	13,380	XX	<sup>r</sup> 8,719	XX	12,553
Total -----	XX	<sup>r</sup> 409,398	XX	<sup>r</sup> 406,609	XX	405,216
ALASKA						
Gem stones -----	NA	<sup>e</sup> \$60	NA	<sup>e</sup> \$60	NA	\$25
Gold (recoverable content of ores, etc.) troy ounces -----	19,433	7,009	44,733	14,210	48,271	17,775
Sand and gravel (construction) thousand short tons -----	30,861	66,883	<sup>e</sup> 29,000	<sup>e</sup> 63,000	27,762	61,954
Silver (recoverable content of ores, etc.) thousand troy ounces -----	( <sup>3</sup> )	1	W	W	W	W
Stone (crushed) ----- thousand short tons ..	<sup>e</sup> 2,500	<sup>e</sup> 10,800	1,907	8,535	<sup>e</sup> 2,000	<sup>e</sup> 8,500
Combined value of cement (portland), tin, and values indicated by symbol W -----	XX	2,543	XX	4,164	XX	3,226
Total -----	XX	87,296	XX	89,969	XX	91,480
ARIZONA						
Clays ----- thousand short tons ..	138	\$819	186	\$1,503	201	\$1,366
Copper (recoverable content of ores, etc.) metric tons -----	746,453	1,100,182	796,556	1,175,995	789,175	1,149,193
Gem stones -----	NA	<sup>e</sup> 2,700	NA	<sup>e</sup> 2,700	NA	2,533
Gold (recoverable content of ores, etc.) troy ounces -----	54,897	19,799	52,053	16,535	W	W
Gypsum ----- thousand short tons ..	261	2,332	251	1,926	260	1,820
Lead (recoverable content of ores, etc.) metric tons -----	W	W	581	244	W	W
Lime ----- thousand short tons ..	359	17,304	476	21,226	505	21,016
Molybdenum ----- thousand pounds ..	24,013	76,112	24,125	63,389	29,382	75,607
Pumice ----- thousand short tons ..	2	21	W	2	2	30
Sand and gravel (construction) ----- do. ....	30,439	101,959	<sup>e</sup> 37,000	<sup>e</sup> 118,000	40,468	140,004

See footnotes at end of table.



Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State — Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ARIZONA—Continued						
Silver (recoverable content of ores, etc.)						
thousand troy ounces	4,247	\$34,570	4,885	\$30,007	4,202	\$22,987
Stone (crushed) ——— thousand short tons	<sup>5</sup> 5,200	<sup>2</sup> 27,300	5,929	23,111	<sup>6</sup> 5,600	<sup>25</sup> 25,100
Combined value of cement, perlite, pyrites (1984-85), salt (1984, 1986), sand and gravel (industrial), stone (dimension), tin (1984), and values indicated by symbol W	XX	<sup>1</sup> 102,840	XX	95,447	XX	116,379
Total	XX	<sup>1</sup> 1,485,938	XX	1,550,085	XX	1,556,035
ARKANSAS						
Clays ——— thousand short tons	1,019	\$7,838	1,052	\$10,769	<sup>2</sup> 974	<sup>28</sup> 28,998
Gem stones	NA	<sup>200</sup>	NA	<sup>200</sup>	NA	522
Sand and gravel:						
Construction ——— thousand short tons	8,334	23,786	<sup>8</sup> 8,500	<sup>24</sup> 24,400	8,571	26,999
Industrial ——— do	459	6,207	412	5,414	400	3,975
Stone:						
Crushed ——— do	<sup>15</sup> 15,200	<sup>59</sup> 59,800	14,815	60,874	<sup>15</sup> 15,500	<sup>58</sup> 58,500
Dimension ——— do	W	W	5	305	<sup>5</sup>	<sup>305</sup>
Combined value of abrasives, bauxite, bromine, cement, clays (fire clay, 1986), gypsum, lime, talc and pyrophyllite, tripoli (1984, 1986), vanadium (1984-85), and value indicated by symbol W	XX	<sup>1</sup> 175,019	XX	<sup>1</sup> 168,290	XX	163,708
Total	XX	<sup>2</sup> 272,850	XX	<sup>2</sup> 270,252	XX	263,007
CALIFORNIA						
Boron minerals ——— thousand short tons	1,367	\$456,687	1,269	\$404,775	1,251	\$426,086
Cement (portland) ——— do	8,715	520,026	9,462	601,506	9,490	578,502
Clays <sup>2</sup> ——— do	2,100	23,868	2,203	26,600	2,449	33,289
Gem stones	NA	<sup>500</sup>	NA	<sup>550</sup>	NA	418
Gold (recoverable content of ores, etc.)						
troy ounces	85,858	30,965	<sup>1</sup> 187,813	<sup>59</sup> 59,660	425,617	156,729
Gypsum ——— thousand short tons	1,382	12,443	1,332	12,201	1,378	10,777
Lime ——— do	406	26,827	367	24,733	371	24,187
Pumice ——— do	80	1,600	78	1,491	46	1,263
Sand and gravel:						
Construction ——— do	102,420	360,427	<sup>112</sup> 112,800	<sup>430</sup> 430,000	128,407	498,456
Industrial ——— do	2,281	39,176	2,255	37,434	2,364	44,813
Silver (recoverable content of ores, etc.)						
thousand troy ounces	W	W	115	709	155	849
Stone:						
Crushed ——— thousand short tons	<sup>38</sup> 38,600	<sup>158</sup> 158,000	41,199	174,395	<sup>38</sup> 38,500	<sup>159</sup> 159,300
Dimension ——— do	<sup>23</sup>	<sup>1,658</sup>	23	2,449	<sup>23</sup>	<sup>2,582</sup>
Talc and pyrophyllite ——— do	74	1,642	100	2,493	64	1,528
Combined value of asbestos, calcium chloride (natural), cement (masonry), clays (ball clay, 1986, and fire clay, 1984-85), copper, diatomite, feldspar, iron ore (usable), lead (1984), magnesium compounds, molybdenum, peat, perlite, potassium salts, rare-earth metal concentrates, salt, sodium carbonate (natural), sodium sulfate (natural), tungsten ore and concentrate, wollastonite (1984, 1986), and value indicated by symbol W	XX	360,085	XX	<sup>333</sup> 333,014	XX	330,638
Total	XX	<sup>1</sup> 1,993,904	XX	<sup>2</sup> 2,112,010	XX	2,269,417

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>COLORADO</b>						
Clays ----- thousand short tons..	308	\$2,111	303	\$1,743	242	\$1,523
Gem stones -----	NA	<sup>e</sup> 80	NA	<sup>e</sup> 80	NA	100
Gold (recoverable content of ores, etc.)	60,010	21,643	43,301	13,755	120,347	44,317
troy ounces -----	291	W	233	1,800	W	W
Gypsum ----- thousand short tons..	28,024	87,324	<sup>e</sup> 27,500	<sup>e</sup> 88,000	23,233	70,095
Sand and gravel:	149	2,213	W	W	W	W
Construction ----- do. ....	2,200	17,909	549	3,370	645	3,526
Industrial ----- do. ....	<sup>e</sup> 7,200	<sup>e</sup> 26,200	7,037	25,930	<sup>e</sup> 8,000	<sup>e</sup> 30,700
Silver (recoverable content of ores, etc.)	<sup>r</sup> 2	<sup>r</sup> <sup>e</sup> 204	2	204	<sup>e</sup> 4	<sup>e</sup> 255
Stone:						
Crushed ----- thousand short tons..	XX	278,609	XX	<sup>r</sup> 273,611	XX	219,492
Dimension ----- do. ....	XX	<sup>r</sup> 436,293	XX	<sup>r</sup> 408,493	XX	370,008
Combined value of cement, copper, iron ore (usable, 1984-85), lead, lime, molybdenum, peat, perlite, pyrites (1984-85), salt (1984), tin (1984-85), tungsten ore and concentrate, vanadium, zinc, and values indicated by symbol W -----						
Total -----						
<b>CONNECTICUT</b>						
Clays ----- thousand short tons..	99	\$565	106	\$632	157	\$975
Gem stones -----	NA	W	NA	W	NA	2
Sand and gravel (construction)	6,718	22,817	<sup>e</sup> 6,000	<sup>e</sup> 21,000	7,254	25,984
thousand short tons.. -----						
Stone:						
Crushed ----- do. ....	<sup>e</sup> 8,300	<sup>e</sup> 49,400	7,277	43,937	<sup>e</sup> 7,700	<sup>e</sup> 45,800
Dimension ----- do. ....	<sup>r</sup> <sup>e</sup> 20	<sup>r</sup> <sup>e</sup> 1,285	20	1,285	<sup>e</sup> 24	<sup>e</sup> 1,653
Combined value of feldspar, lime (1984), mica (scrap), sand and gravel (industrial), and values indicated by symbol W -----	XX	5,834	XX	5,532	XX	6,040
Total -----	XX	<sup>r</sup> 79,901	XX	72,386	XX	80,454
<b>DELAWARE</b>						
Gem stones -----	--	--	--	--	NA	\$1
Marl (greensand) ----- thousand short tons..	1	\$18	2	\$29	1	12
Sand and gravel (construction) ----- do. ....	1,003	2,795	<sup>e</sup> 1,300	<sup>e</sup> 4,000	1,547	4,156
Total <sup>4</sup> -----	XX	2,813	XX	4,029	XX	4,169
<b>FLORIDA</b>						
Cement:						
Masonry ----- thousand short tons..	383	\$24,624	316	\$17,137	352	\$21,269
Portland ----- do. ....	3,564	172,548	3,282	148,908	3,189	147,643
Clays ----- do. ....	772	34,048	672	33,074	726	43,261
Gem stones -----	NA	<sup>e</sup> 6	NA	<sup>e</sup> 6	NA	W
Lime ----- thousand short tons..	171	9,379	W	W	W	W
Peat ----- do. ....	263	5,454	243	5,333	365	5,743
Sand and gravel:						
Construction ----- do. ....	21,032	48,494	<sup>e</sup> 22,500	<sup>e</sup> 49,500	28,233	67,898
Industrial ----- do. ....	1,533	9,815	2,123	12,642	1,467	14,930
Stone (crushed) ----- do. ....	<sup>e</sup> 68,500	<sup>e</sup> 290,000	69,266	287,237	<sup>e</sup> 69,000	<sup>e</sup> 288,200
Combined value of magnesium compounds (1984), phosphate rock, rare-earth metal concentrates, staurolite, titanium concentrates (ilmenite and rutile), zircon concentrate, and values indicated by symbol W -----	XX	915,996	XX	<sup>r</sup> 1,007,899	XX	706,209
Total -----	XX	1,510,364	XX	<sup>r</sup> 1,561,736	XX	1,295,153
<b>GEORGIA</b>						
Clays ----- thousand short tons..	8,679	\$600,029	8,671	\$575,097	9,827	\$669,200
Gem stones -----	NA	<sup>e</sup> 20	NA	<sup>e</sup> 20	NA	20

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State—Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
GEORGIA—Continued						
Sand and gravel:						
Construction thousand short tons	5,347	\$13,623	*5,000	*\$13,400	8,126	\$23,222
Industrial do	478	6,795	571	6,675	W	W
Stone:						
Crushed do	*45,900	*220,000	52,062	256,588	*56,700	*293,100
Dimension do	<sup>r</sup> 184	<sup>r</sup> 19,660	<sup>r</sup> 183	19,466	<sup>e</sup> 199	<sup>e</sup> 20,678
Talc and pyrophyllite do	15	104	16	111	9	61
Combined value of barite, bauxite (1984), cement, feldspar, iron oxide pigments (crude), kyanite, mica (scrap), peat, and value indicated by symbol W	XX	79,914	XX	74,718	XX	85,174
Total	XX	<sup>r</sup> 940,145	XX	946,075	XX	1,091,455
HAWAII						
Cement:						
Masonry thousand short tons	5	\$792	7	\$588	7	\$1,078
Portland do	186	18,282	215	16,050	287	24,253
Gem stones	NA	<sup>e</sup> 25	NA	<sup>e</sup> 25	NA	25
Lime thousand short tons	W	W	W	W	3	W
Sand and gravel (construction) do	436	2,031	*500	*2,100	605	2,666
Stone (crushed) do	*5,400	*29,700	5,627	34,183	*7,100	*42,100
Combined value of other industrial minerals and values indicated by symbol W	XX	<sup>r</sup> 417	XX	<sup>r</sup> 326	XX	290
Total	XX	51,247	XX	53,272	XX	70,412
IDAHO						
Antimony	557	W	W	W	W	W
Clays <sup>2</sup> thousand short tons	1	W	2	W	2	W
Copper (recoverable content of ores, etc.) metric tons	3,701	\$5,455	3,551	\$5,242	W	W
Gem stones	NA	<sup>e</sup> 150	NA	<sup>r</sup> 175	NA	\$305
Gold (recoverable content of ores, etc.) troy ounces	W	W	44,306	14,074	70,440	25,938
Lead (recoverable content of ores, etc.) metric tons	W	W	33,707	14,169	9,951	4,836
Lime thousand short tons	87	5,616	93	5,803	89	4,729
Phosphate rock thousand metric tons	4,722	126,586	3,784	<sup>r</sup> 104,000	2,625	55,000
Sand and gravel (construction) thousand short tons	4,725	13,509	*4,000	*11,400	5,708	14,830
Silver (recoverable content of ores, etc.) thousand troy ounces	18,869	153,608	18,828	115,645	11,207	61,301
Stone (crushed) thousand short tons	*1,800	*7,100	2,019	6,977	*3,700	*12,700
Zinc (recoverable content of ores, etc.) metric tons	W	W	W	W	351	294
Combined value of cement, clays (bentonite, common clay (1986), fire clay, kaolin), garnet (abrasive), gypsum (1984), molybdenum, perlite, pumice, sand and gravel (industrial), stone (dimension), vanadium, and values indicated by symbol W	XX	<sup>r</sup> 100,327	XX	<sup>r</sup> 81,181	XX	66,783
Total	XX	<sup>r</sup> 412,351	XX	<sup>r</sup> 358,666	XX	246,716
ILLINOIS						
Cement (portland) thousand short tons	1,997	\$82,622	2,101	\$86,211	2,118	\$83,783
Clays <sup>2</sup> do	253	940	265	876	283	1,092
Gem stones	NA	<sup>e</sup> 15	NA	<sup>e</sup> 15	NA	15
Peat thousand short tons	49	W	W	W	W	W
Sand and gravel:						
Construction do	25,969	72,477	*26,600	*77,000	27,867	82,523
Industrial do	4,100	52,197	4,056	56,915	4,039	52,133
Stone:						
Crushed do	*48,500	*191,600	41,044	164,117	*44,200	*179,600
Dimension do	<sup>r</sup> 2	<sup>r</sup> 4107	2	107	<sup>e</sup> 2	<sup>e</sup> 107
Combined value of barite (1984-85), cement (masonry), clays (fuller's earth), copper (1985-86), fluorspar, lead, lime, silver, tripoli, zinc, and values indicated by symbol W	XX	72,010	XX	74,679	XX	70,272
Total	XX	<sup>r</sup> 471,968	XX	459,920	XX	469,525

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>INDIANA</b>						
Cement:						
Masonry ----- thousand short tons .....	W	W	W	W	395	\$22,986
Portland ----- do. ....	W	W	W	W	2,136	92,327
Clays ----- do. ....	<sup>2</sup> 653	<sup>2</sup> \$2,085	740	\$2,776	744	3,044
Gem stones ----- do. ....	NA	<sup>1</sup>	NA	<sup>1</sup>	NA	1
Peat ----- thousand short tons .....	61	1,358	54	W	79	W
Sand and gravel:						
Construction ----- do. ....	16,071	44,744	<sup>1</sup> 18,600	<sup>1</sup> 55,800	19,642	61,232
Industrial ----- do. ....	194	1,129	182	1,209	193	1,490
Stone:						
Crushed ----- do. ....	<sup>2</sup> 26,700	<sup>2</sup> 99,400	<sup>2</sup> 23,384	<sup>2</sup> 81,119	<sup>2</sup> 22,600	<sup>2</sup> 76,500
Dimension ----- do. ....	<sup>1</sup> 163	<sup>1</sup> 17,113	<sup>1</sup> 169	20,186	<sup>1</sup> 191	<sup>1</sup> 20,252
Combined value of abrasives, clays (fire clay, 1984), gypsum, lime, stone (crushed marl, 1985-86), and values indicated by symbol W	XX	130,250	XX	141,863	XX	27,566
Total .....	XX	<sup>1</sup> 296,080	XX	302,954	XX	305,348
<b>IOWA</b>						
Cement:						
Masonry ----- thousand short tons .....	42	\$3,260	39	\$3,372	48	\$3,199
Portland ----- do. ....	1,730	92,699	1,618	77,890	1,819	86,984
Clays ----- do. ....	623	2,695	503	2,450	486	1,421
Gem stones ----- do. ....	NA	W	NA	<sup>1</sup>	NA	20
Gypsum ----- thousand short tons .....	1,527	12,421	1,639	13,682	1,826	12,602
Peat ----- do. ....	11	400	11	415	14	381
Sand and gravel (construction) ----- do. ....	13,882	37,027	<sup>1</sup> 12,000	<sup>1</sup> 30,500	14,511	40,418
Stone (crushed) ----- do. ....	<sup>2</sup> 23,800	<sup>2</sup> 100,000	23,657	94,496	<sup>2</sup> 23,400	<sup>2</sup> 98,000
Combined value of other industrial minerals and value indicated by symbol W	XX	<sup>1</sup> 5,246	XX	5,211	XX	5,707
Total .....	XX	<sup>1</sup> 253,748	XX	228,017	XX	248,732
<b>KANSAS</b>						
Cement:						
Masonry ----- thousand short tons .....	W	W	W	W	51	\$3,264
Portland ----- do. ....	W	W	W	W	1,763	91,110
Clays ----- do. ....	918	\$5,537	878	\$5,326	903	5,295
Gem stones ----- do. ....	NA	<sup>1</sup>	NA	<sup>1</sup>	NA	3
Helium:						
Crude ----- million cubic feet .....	402	8,844	W	W	W	W
Grade-A ----- do. ....	1,015	38,063	W	W	W	W
Salt <sup>2</sup> ----- thousand short tons .....	1,712	71,558	1,790	71,970	1,656	68,887
Sand and gravel:						
Construction ----- do. ....	11,796	26,358	<sup>1</sup> 13,200	<sup>1</sup> 31,800	15,609	33,721
Industrial ----- do. ....	W	W	134	1,124	132	1,155
Stone (crushed) ----- do. ....	<sup>1</sup> 13,600	<sup>1</sup> 48,500	15,653	57,155	<sup>1</sup> 16,600	<sup>1</sup> 60,300
Combined value of gypsum, lime (1984), pumice, salt (brine), stone (dimension), and values indicated by symbol W	XX	<sup>1</sup> 113,774	XX	<sup>1</sup> 154,793	XX	53,910
Total .....	XX	<sup>1</sup> 312,635	XX	<sup>1</sup> 322,169	XX	317,645
<b>KENTUCKY</b>						
Clays ----- thousand short tons .....	<sup>2</sup> 662	<sup>2</sup> \$2,533	775	\$6,487	<sup>2</sup> 721	<sup>2</sup> \$3,450
Gem stones ----- do. ....	NA	<sup>1</sup>	NA	<sup>1</sup>	NA	3
Sand and gravel (construction) ----- do. ....	7,839	18,252	<sup>1</sup> 7,600	<sup>1</sup> 19,000	7,194	16,986
Stone (crushed) ----- do. ....	<sup>2</sup> 37,300	<sup>2</sup> 133,000	<sup>2</sup> 38,022	<sup>2</sup> 134,978	<sup>2</sup> 38,400	<sup>2</sup> 137,000
Combined value of cement, clays (ball clay and fire clay, 1984, 1986), lime, sand and gravel (industrial), stone (crushed sandstone, 1985-86), and zinc (1984-85)	XX	103,422	XX	107,092	XX	109,826
Total .....	XX	257,208	XX	267,558	XX	267,265

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
LOUISIANA						
Clays ----- thousand short tons ..	<sup>2</sup> 547	<sup>2</sup> \$10,858	334	\$7,017	332	\$7,670
Gem stones ----- do ..	NA	<sup>e1</sup>	NA	<sup>e1</sup>	NA	1
Salt ----- thousand short tons ..	13,101	112,142	<sup>r</sup> 12,271	<sup>r</sup> 137,273	11,608	103,611
Sand and gravel:						
Construction ----- do ..	17,040	54,664	<sup>e</sup> 15,000	<sup>e</sup> 48,000	14,292	46,134
Industrial ----- do ..	266	3,757	267	3,838	256	4,225
Stone (crushed) ----- do ..	<sup>e</sup> 4,100	<sup>e</sup> 19,500	<sup>e</sup> 4,820	<sup>e</sup> 25,956	<sup>e</sup> 5,400	<sup>e</sup> 25,300
Sulfur (Frasch) ----- thousand metric tons ..	2,007	W	1,698	W	1,602	W
Combined value of cement (masonry, 1984-85, and portland), clays (bentonite, 1984), gypsum (1984-85), lime, stone (crushed miscellaneous, 1985-86), and values indicated by symbol W ..	XX	310,548	XX	298,501	XX	259,857
Total ..	XX	511,470	XX	<sup>r</sup> 520,586	XX	446,798
MAINE						
Clays ----- thousand short tons ..	43	\$97	50	\$100	46	\$90
Gem stones ----- do ..	NA	<sup>e</sup> 400	NA	<sup>e</sup> 400	NA	200
Sand and gravel (construction) ----- thousand short tons ..	7,885	19,228	<sup>e</sup> 7,200	<sup>e</sup> 18,000	8,572	22,843
Stone (crushed) ----- do ..	<sup>e</sup> 1,300	<sup>e</sup> 4,400	1,459	5,114	<sup>e</sup> 1,600	<sup>e</sup> 4,400
Combined value of cement, garnet (abrasive), peat (1984, 1986), and stone (dimension) ..	XX	<sup>r</sup> 14,088	XX	17,494	XX	25,826
Total ..	XX	<sup>r</sup> 38,213	XX	41,108	XX	52,859
MARYLAND						
Cement (portland) ----- thousand short tons ..	W	W	W	W	1,785	\$89,799
Clays <sup>2</sup> ----- do ..	347	\$1,484	336	\$1,647	362	1,757
Gem stones ----- do ..	NA	<sup>e</sup> 2	NA	<sup>e</sup> 2	NA	5
Lime ----- thousand short tons ..	7	419	10	608	10	546
Peat ----- do ..	5	W	W	W	W	W
Sand and gravel (construction) ----- do ..	14,234	46,671	<sup>e</sup> 17,000	<sup>e</sup> 58,000	18,173	86,925
Stone:						
Crushed ----- do ..	<sup>e</sup> 22,100	<sup>e</sup> 94,000	24,406	98,584	<sup>e</sup> 26,400	<sup>e</sup> 126,000
Dimension ----- do ..	<sup>r</sup> <sup>e</sup> 16	<sup>r</sup> <sup>e</sup> 1,065	18	1,218	<sup>e</sup> 21	<sup>e</sup> 1,286
Combined value of cement (masonry), clays (ball clay), sand and gravel (industrial), and values indicated by symbol W ..	XX	98,261	XX	98,215	XX	7,027
Total ..	XX	<sup>r</sup> 241,902	XX	258,274	XX	313,345
MASSACHUSETTS						
Clays ----- thousand short tons ..	240	\$1,212	265	\$1,388	140	\$871
Lime ----- do ..	171	12,426	159	10,935	W	W
Sand and gravel:						
Construction ----- do ..	14,168	42,139	<sup>e</sup> 14,900	<sup>e</sup> 47,500	19,200	60,464
Industrial ----- do ..	W	W	W	W	45	739
Stone:						
Crushed ----- do ..	<sup>e</sup> 8,400	<sup>e</sup> 39,000	9,354	42,881	<sup>e</sup> 10,000	<sup>e</sup> 50,000
Dimension ----- do ..	<sup>r</sup> <sup>e</sup> 64	<sup>r</sup> <sup>e</sup> 11,688	73	13,724	<sup>e</sup> 79	<sup>e</sup> 14,928
Combined value of gem stones, peat, and values indicated by symbol W ..	XX	898	XX	777	XX	7,395
Total ..	XX	<sup>r</sup> 107,363	XX	117,205	XX	134,397
MICHIGAN						
Cement:						
Masonry ----- thousand short tons ..	W	W	W	W	257	\$17,026
Portland ----- do ..	W	W	W	W	4,713	216,130
Clays ----- do ..	1,321	\$5,052	1,477	\$5,514	1,402	5,684
Gem stones ----- do ..	NA	<sup>e</sup> 15	NA	<sup>e</sup> 15	NA	25
Gypsum ----- thousand short tons ..	1,534	10,304	1,772	11,883	1,979	11,052
Iron ore (usable) ----- thousand long tons, gross weight ..	13,263	W	12,629	W	10,957	W

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>MICHIGAN—Continued</b>						
Lime ----- thousand short tons..	622	\$30,092	535	\$24,790	556	\$27,257
Peat ----- do .....	227	4,341	282	5,414	298	6,170
Salt ----- do .....	1,491	93,860	<sup>2</sup> 927	<sup>1</sup> 71,224	W	W
Sand and gravel:						
Construction ----- do .....	36,071	76,540	<sup>3</sup> 38,000	<sup>3</sup> 93,000	42,514	91,886
Industrial ----- do .....	3,400	33,060	3,345	25,469	3,343	29,493
Stone:						
Crushed ----- do .....	<sup>6</sup> 28,100	<sup>6</sup> 92,000	30,685	95,953	<sup>6</sup> 27,800	<sup>6</sup> 83,900
Dimension ----- do .....	<sup>4</sup>	<sup>1</sup> 113	4	113	<sup>6</sup>	<sup>1</sup> 148
Combined value of bromine, calcium chloride (natural), copper (1985-86), gold (1985-86), iodine (1984-85), iron oxide pigments (crude), magnesium compounds, silver (1985-86), and values indicated by symbol W	XX	1,063,214	XX	<sup>1</sup> 1,053,672	XX	764,089
Total -----	XX	<sup>1</sup> 1,408,591	XX	<sup>1</sup> 1,387,047	XX	1,252,850
<b>MINNESOTA</b>						
Gem stones -----	NA	<sup>3</sup> \$5	NA	<sup>3</sup> \$5	NA	\$5
Iron ore (usable) ----- thousand long tons, gross weight..	35,602	1,561,516	34,977	1,430,353	28,779	1,017,261
Manganiferous ore ----- short tons..	68,019	W	W	W	W	W
Peat ----- thousand short tons..	24	W	34	1,720	W	W
Sand and gravel:						
Construction ----- do .....	22,612	49,087	<sup>2</sup> 25,000	<sup>5</sup> 55,500	24,055	53,116
Industrial ----- do .....	W	W	884	16,910	W	W
Stone:						
Crushed ----- do .....	<sup>8</sup> 8,900	<sup>2</sup> 25,800	7,756	22,601	<sup>8</sup> 8,300	<sup>2</sup> 26,300
Dimension ----- do .....	<sup>1</sup> 40	<sup>1</sup> 13,557	37	18,598	<sup>2</sup> 28	<sup>6</sup> 10,507
Combined value of clays, lime, and values indicated by symbol W	XX	26,470	XX	7,271	XX	20,438
Total -----	XX	<sup>1</sup> 1,676,435	XX	1,547,958	XX	1,127,627
<b>MISSISSIPPI</b>						
Clays ----- thousand short tons..	<sup>2</sup> 1,274	<sup>1</sup> 210,367	1,558	\$34,864	<sup>2</sup> 928	<sup>2</sup> \$13,538
Gem stones -----	---	---	---	---	NA	1
Sand and gravel (construction) ----- thousand short tons..	12,205	34,955	<sup>1</sup> 13,400	<sup>4</sup> 42,000	15,080	42,809
Stone (crushed) ----- do .....	<sup>2</sup> 2,000	<sup>5</sup> 5,800	1,582	4,282	<sup>1</sup> 1,600	<sup>6</sup> 4,400
Combined value of cement, clays (ball clay and fuller's earth, 1984, 1986), and sand and gravel (industrial)	XX	42,016	XX	21,647	XX	40,347
Total -----	XX	<sup>1</sup> 93,138	XX	102,793	XX	101,095
<b>MISSOURI</b>						
Barite ----- thousand short tons..	W	W	47	\$2,791	W	W
Cement:						
Masonry ----- do .....	143	\$7,033	139	6,630	167	\$7,816
Portland ----- do .....	3,981	173,225	3,669	159,757	4,642	179,184
Clays <sup>2</sup> ----- do .....	1,575	14,666	1,545	10,271	1,321	6,650
Copper (recoverable content of ores, etc.) ----- metric tons..	5,818	8,575	13,410	19,797	W	W
Gem stones -----	NA	<sup>10</sup>	NA	<sup>10</sup>	NA	W
Iron ore (usable) ----- thousand long tons, gross weight..	1,370	W	1,110	W	803	W
Lead (recoverable content of ores, etc.) ----- metric tons..	278,329	156,766	371,008	155,955	319,900	155,481
Sand and gravel:						
Construction ----- thousand short tons..	7,967	19,364	<sup>7</sup> 7,500	<sup>20</sup> 20,000	9,746	24,065
Industrial ----- do .....	614	8,129	535	7,330	517	6,230
Silver (recoverable content of ores, etc.) ----- thousand troy ounces..	1,401	11,406	1,635	10,044	1,459	7,982
Stone (crushed) ----- thousand short tons..	<sup>4</sup> 41,600	<sup>1</sup> 137,000	50,646	162,097	<sup>5</sup> 51,200	<sup>1</sup> 170,500
Zinc (recoverable content of ores, etc.) ----- metric tons..	45,458	48,707	49,340	43,908	37,919	31,767
Combined value of clays (fuller's earth), iron oxide pigments (crude), lime, stone (dimension), and values indicated by symbol W	XX	<sup>1</sup> 142,104	XX	136,370	XX	158,910
Total -----	XX	<sup>1</sup> 731,985	XX	734,960	XX	748,585

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>MONTANA</b>						
Clays ----- thousand short tons .....	229	\$5,642	279	\$3,296	222	\$5,882
Copper (recoverable content of ores, etc.) metric tons .....	W	W	15,092	22,281	W	W
Gem stones ----- do. ....	NA	*450	NA	*400	NA	480
Gold (recoverable content of ores, etc.) troy ounces .....	181,190	65,348	160,262	50,909	W	W
Lead (recoverable content of ores, etc.) metric tons .....	W	W	846	356	W	W
Lime ----- thousand short tons .....	89	5,097	W	W	W	W
Sand and gravel (construction) ----- do. ....	7,776	21,269	*9,000	*26,000	8,066	19,391
Silver (recoverable content of ores, etc.) thousand troy ounces .....	5,653	46,018	4,010	24,630	4,773	26,110
Stone (crushed) ----- thousand short tons .....	*950	*2,400	*1,730	*5,044	*2,200	*6,200
Combined value of barite (1984-85), cement, graphite (1984), gypsum, iron ore (usable), molybdenum (1986), peat, phosphate rock, sand and gravel (industrial), stone (crushed traprock, 1985-86), stone (dimension), talc and pyrophyllite, vermiculite, and values indicated by symbol W .....	XX	†93,777	XX	†62,166	XX	178,897
Total .....	XX	†240,001	XX	†200,082	XX	236,960
<b>NEBRASKA</b>						
Clays ----- thousand short tons .....	180	\$556	244	\$718	221	\$668
Gem stones ----- do. ....	NA	W	NA	*10	NA	10
Sand and gravel (construction) thousand short tons .....	11,839	27,791	*11,600	*28,800	9,675	23,912
Stone (crushed) ----- do. ....	*4,500	*23,400	4,175	19,134	*4,000	*17,900
Combined value of cement, lime, sand and gravel (industrial), and value indicated by symbol W .....	XX	48,621	XX	51,308	XX	51,598
Total .....	XX	100,368	XX	99,970	XX	94,088
<b>NEVADA</b>						
Barite ----- thousand short tons .....	615	\$14,924	590	\$10,904	184	\$3,005
Clays <sup>2</sup> ----- do. ....	20	1,191	80	3,776	10	584
Gem stones ----- do. ....	NA	*1,300	NA	*1,300	NA	213
Gold (recoverable content of ores, etc.) troy ounces .....	1,020,546	368,068	1,276,114	405,369	2,098,929	772,909
Gypsum ----- thousand short tons .....	1,192	8,860	1,207	8,942	1,236	8,221
Lead (recoverable content of ores, etc.) metric tons .....	W	W	( <sup>3</sup> )	( <sup>3</sup> )	W	W
Mercury ----- 76-pound flasks .....	19,048	W	16,530	W	W	W
Perlite ----- short tons .....	W	W	W	W	4	122
Sand and gravel: Construction ----- thousand short tons .....	8,202	20,505	*9,500	†24,880	12,197	35,692
Industrial ----- do. ....	489	W	479	W	518	W
Silver (recoverable content of ores, etc.) thousand troy ounces .....	6,477	52,727	4,947	30,383	6,409	35,056
Stone (crushed) ----- thousand short tons .....	*1,100	*4,700	1,334	6,218	*1,500	*7,000
Combined value of cement (portland), clays (fuller's earth and kaolin), copper, diato- mite, fluorspar, iron ore (usable), lime, lithium minerals, magnesite, molybdenum (1984-85), salt, tungsten ore and concen- trate (1984), and values indicated by symbol W .....	XX	151,787	XX	†139,201	XX	114,529
Total .....	XX	624,062	XX	†630,973	XX	977,331
<b>NEW HAMPSHIRE</b>						
Sand and gravel (construction) thousand short tons .....	5,637	\$16,054	*6,300	*\$19,800	8,418	\$26,089
Stone: Crushed ----- do. ....	*850	*2,700	1,612	6,434	*1,800	*5,900
Dimension ----- do. ....	†83	†5,681	†80	†6,625	†82	†6,451
Combined value of other industrial minerals .....	XX	160	XX	134	XX	137
Total .....	XX	†24,595	XX	†32,993	XX	38,577

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>NEW JERSEY</b>						
Clays ----- thousand short tons ..	62	\$611	130	\$2,050	133	\$2,066
Gem stones ----- short tons ..	NA	*1	NA	*1	NA	3
Peat ----- thousand short tons ..	5	128	W	311	W	542
Sand and gravel:						
Construction ----- do. ....	9,545	31,878	*10,600	*36,700	13,999	53,746
Industrial ----- do. ....	2,712	32,287	2,820	31,119	2,341	29,878
Stone (crushed) ----- do. ....	*13,500	*75,000	15,692	94,339	*15,300	*95,400
Combined value of other industrial minerals	XX	†16,183	XX	13,056	XX	4,613
Total -----	XX	†156,088	XX	177,576	XX	186,248
<b>NEW MEXICO</b>						
Clays ----- thousand short tons ..	67	\$143	60	\$161	60	\$170
Gem stones ----- short tons ..	NA	*200	NA	*200	NA	200
Gold (recoverable content of ores, etc.)	W	W	45,045	14,309	39,856	14,677
----- troy ounces ..			350	1,570	W	W
Gypsum ----- thousand short tons ..	318	1,622	W	W	10	5
Lead (recoverable content of ores, etc.)			W	W	13	5
----- metric tons ..					433	13,727
Perlite ----- thousand short tons ..	416	14,115	†430	†14,896	987	132,800
Potassium salts ----- thousand metric tons ..	1,418	204,100	1,120	156,000	255	2,370
Pumice ----- thousand short tons ..	132	1,269	152	1,114	8,471	25,862
Sand and gravel (construction) ----- do. ....	8,363	22,389	*8,400	*22,800	8,471	25,862
Stone:						
Crushed ----- do. ....	*4,700	*17,000	3,641	15,232	*3,900	*15,300
Dimension ----- do. ....	†*20	†*185	20	277	*22	*378
Combined value of cement, copper, helium (Grade-A), iron ore (usable, 1986), mica (scrap), molybdenum, salt, silver, tungsten ore and concentrate (1984), and values indicated by symbol W -----	XX	374,855	XX	430,705	XX	406,586
Total -----	XX	*635,878	XX	†657,264	XX	612,075
<b>NEW YORK</b>						
Clays ----- thousand short tons ..	*543	*2,435	700	\$3,129	619	\$3,075
Emery ----- short tons ..	W	W	W	W	2,878	W
Gem stones ----- short tons ..	NA	*30	NA	*30	NA	100
Salt ----- thousand short tons ..	5,644	123,755	†7,044	142,318	5,071	122,601
Sand and gravel:						
Construction ----- do. ....	25,968	80,866	*28,000	*88,500	31,172	103,748
Industrial ----- do. ....	25	260	W	W	59	1,164
Stone:						
Crushed ----- do. ....	*33,100	*135,000	35,139	165,136	*40,600	*196,600
Dimension ----- do. ....	*15	†*3,072	16	3,666	*16	*3,002
Combined value of cement, clays (ball clay, 1984), garnet (abrasive), gypsum, lead, lime (1984-85), peat, silver, talc and pyrophyllite, titanium concentrate (ilmenite, 1984), wolastonite, zinc, and values indicated by symbol W -----	XX	265,873	XX	254,529	XX	247,272
Total -----	XX	†611,291	XX	657,308	XX	677,562
<b>NORTH CAROLINA</b>						
Clays ----- thousand short tons ..	2,327	\$3,987	2,688	\$10,477	2,658	\$10,970
Feldspar ----- short tons ..	510,275	13,994	490,993	13,351	526,672	15,568
Gem stones ----- short tons ..	NA	*50	NA	*50	NA	551
Gold (recoverable content of ores, etc.)						
----- troy ounces ..					12	4
Mica (scrap) ----- thousand short tons ..	79	3,762	80	3,726	89	4,641
Peat ----- thousand short tons ..	W	W	W	W	15	W
Sand and gravel:						
Construction ----- do. ....	6,312	18,159	*6,100	*19,500	7,543	23,127
Industrial ----- do. ....	1,158	12,864	1,294	13,086	1,464	16,656
Stone:						
Crushed ----- do. ....	*38,100	*168,000	41,771	194,818	*43,500	*206,500
Dimension ----- do. ....	†*35	†*5,970	35	6,132	*41	*6,633

See footnotes at end of table.



Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State—Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NORTH CAROLINA—Continued						
Talc and pyrophyllite	87	\$1,587	885	\$1,604	83	\$1,552
thousand short tons						
Combined value of lithium minerals, olivine, phosphate rock, and values indicated by symbol W	XX	‡215,897	XX	‡202,642	XX	180,221
Total	XX	‡449,270	XX	‡465,386	XX	466,423
NORTH DAKOTA						
Gem stones	NA	*\$2	NA	*\$2	NA	\$2
Lime	60	5,912	56	5,562	74	7,359
thousand short tons						
Sand and gravel (construction)	6,426	11,351	*6,900	*13,800	5,135	10,741
do.						
Combined value of clays, peat, salt, sand and gravel (industrial, 1986), and stone (crushed miscellaneous, 1985-86)	XX	4,529	XX	4,820	XX	2,700
Total	XX	21,794	XX	24,184	XX	20,802
OHIO						
Cement:						
Masonry	101	\$8,092	110	\$10,412	138	\$11,540
thousand short tons						
Portland	1,525	69,810	1,769	84,929	1,706	79,383
do.						
Clays	1,960	10,473	2,114	10,581	2,833	11,515
do.						
Gem stones	NA	W	NA	*10	NA	10
Lime	1,859	87,951	1,730	84,142	1,648	81,103
thousand short tons						
Peat	13	845	16	413	6	W
do.						
Salt	W	W	‡4,329	‡130,964	4,115	126,757
do.						
Sand and gravel:						
Construction	31,748	104,709	*33,000	*109,000	36,806	126,747
do.						
Industrial	1,506	20,829	1,312	21,945	1,221	21,183
do.						
Stone:						
Crushed	*38,500	*139,000	38,310	136,544	*39,300	*147,300
do.						
Dimension	‡55	‡2,364	53	3,661	*36	*2,708
do.						
Combined value of abrasives, gypsum, and values indicated by symbol W	XX	108,240	XX	1,541	XX	1,738
Total	XX	‡551,813	XX	‡594,142	XX	609,984
OKLAHOMA						
Cement:						
Masonry	49	\$3,506	43	\$2,854	50	\$3,198
thousand short tons						
Portland	1,732	84,701	1,589	72,583	1,579	69,075
do.						
Clays	979	2,498	997	2,338	993	2,329
do.						
Gem stones	NA	*2	NA	*2	NA	2
Gypsum	1,549	13,485	1,595	12,548	1,683	9,855
thousand short tons						
Sand and gravel:						
Construction	10,984	26,582	*12,600	*32,300	10,366	24,585
do.						
Industrial	W	W	W	W	1,203	16,454
do.						
Stone:						
Crushed	*25,500	*86,000	31,173	98,811	*30,900	*102,100
do.						
Dimension	‡9	‡584	11	836	*19	*913
do.						
Combined value of feldspar, iodine, lime, pumice, salt, tripoli, and values indicated by symbol W	XX	28,187	XX	29,335	XX	18,504
Total	XX	‡245,545	XX	251,607	XX	247,015
OREGON						
Clays	189	\$288	188	\$285	204	\$289
thousand short tons						
Gem stones	NA	*400	NA	*350	NA	350
Nickel (content of ore and concentrate)	14,540	W	6,127	W	1,175	W
short tons						
Sand and gravel (construction)	12,776	37,117	*12,500	*36,800	13,441	42,597
thousand short tons						
Stone (crushed)	*12,500	*37,500	15,336	54,244	*15,100	*58,400
do.						
Talc and pyrophyllite	( <sup>b</sup> )	66	( <sup>b</sup> )	30	( <sup>b</sup> )	41
do.						
Combined value of cement, diatomite, gold, lime, pumice, silver (1984), stone (dimension), and values indicated by symbol W	XX	45,031	XX	38,587	XX	29,755
Total	XX	120,402	XX	130,296	XX	126,432

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State—Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>PENNSYLVANIA</b>						
Cement:						
Masonry ----- thousand short tons..	298	\$20,849	303	\$20,970	391	\$26,683
Portland ----- do. ....	5,735	281,590	5,535	288,036	6,290	324,187
Clays <sup>2</sup> ----- do. ....	963	4,050	1,142	5,293	1,234	5,061
Gem stones ----- do. ....	NA	<sup>e</sup> 5	NA	<sup>e</sup> 5	NA	5
Lime ----- thousand short tons..	1,620	90,182	1,492	85,269	1,417	81,234
Peat ----- do. ....	24	693	21	602	19	532
Sand and gravel:						
Construction ----- do. ....	14,472	64,285	<sup>e</sup> 17,000	<sup>e</sup> 74,000	15,373	68,880
Industrial ----- do. ....	W	W	693	9,846	688	10,091
Stone:						
Crushed ----- do. ....	<sup>e</sup> 56,200	<sup>e</sup> 228,000	64,765	310,859	<sup>e</sup> 63,700	<sup>e</sup> 317,100
Dimension ----- do. ....	<sup>r</sup> 93	<sup>r</sup> 7,026	51	8,214	<sup>r</sup> 72	<sup>e</sup> 8,100
Combined value of clays (kaolin), mica (scrap), tripoli (1986), and value indicated by symbol W -----	XX	12,701	XX	1,380	XX	1,185
Total -----	XX	<sup>r</sup> 709,381	XX	804,474	XX	843,058
<b>RHODE ISLAND</b>						
Sand and gravel:						
Construction ----- thousand short tons..	1,483	\$5,282	<sup>e</sup> 1,200	<sup>e</sup> \$4,600	2,269	\$8,252
Industrial ----- do. ....	W	W	W	W	22	143
Stone (crushed) ----- do. ....	<sup>e</sup> 1,000	<sup>e</sup> 5,800	<sup>e</sup> 1,135	<sup>e</sup> 7,016	<sup>e</sup> 51,000	<sup>e</sup> 5,700
Combined value of other industrial minerals and values indicated by symbol W -----	XX	<sup>r</sup> 466	XX	576	XX	101
Total -----	XX	<sup>r</sup> 11,548	XX	12,192	XX	14,196
<b>SOUTH CAROLINA</b>						
Cement (portland) ----- thousand short tons..	2,319	\$103,891	2,207	\$104,705	2,306	\$109,529
Clays <sup>2</sup> ----- do. ....	1,834	36,809	1,896	37,695	1,986	37,980
Gem stones ----- do. ....	NA	<sup>e</sup> 10	NA	<sup>e</sup> 10	NA	10
Manganiferous ore ----- short tons..	20,404	W	19,882	W	14,320	W
Peat ----- thousand short tons..	5	W	W	173	W	W
Sand and gravel:						
Construction ----- do. ....	5,845	17,097	<sup>e</sup> 4,900	<sup>e</sup> 14,000	7,200	19,783
Industrial ----- do. ....	882	14,889	794	14,092	800	14,081
Stone:						
Crushed ----- do. ....	<sup>e</sup> 17,900	<sup>e</sup> 72,500	17,079	72,520	<sup>e</sup> 18,200	<sup>e</sup> 76,700
Dimension ----- do. ....	<sup>r</sup> 8	<sup>r</sup> 537	8	541	<sup>e</sup> 8	<sup>e</sup> 533
Combined value of cement (masonry), clays (fuller's earth), gold (1985-86), mica (scrap), silver (1985-86), vermiculite, and values indicated by symbol W -----	XX	29,562	XX	32,193	XX	37,273
Total -----	XX	<sup>r</sup> 275,295	XX	275,929	XX	295,889
<b>SOUTH DAKOTA</b>						
Cement:						
Masonry ----- thousand short tons..	5	\$283	4	W	4	W
Portland ----- do. ....	619	30,773	655	W	635	W
Clays <sup>2</sup> ----- do. ....	119	343	117	\$309	119	\$375
Feldspar ----- short tons..	7,219	124	13,721	W	W	W
Gem stones ----- do. ....	NA	<sup>e</sup> 70	NA	<sup>e</sup> 70	NA	100
Gold (recoverable content of ores, etc.) -----						
troy ounces..	310,527	111,994	356,103	113,119	W	W
Gypsum ----- thousand short tons..	W	W	34	269	31	268
Sand and gravel (construction) ----- do. ....	5,786	12,168	<sup>e</sup> 6,400	<sup>e</sup> 16,000	9,713	19,853
Silver (recoverable content of ores, etc.) -----						
thousand troy ounces..	50	407	63	388	W	W
Stone:						
Crushed ----- thousand short tons..	<sup>e</sup> 3,800	<sup>e</sup> 12,800	4,071	14,412	<sup>e</sup> 3,600	<sup>e</sup> 12,600
Dimension ----- do. ....	<sup>r</sup> 57	<sup>r</sup> 18,032	<sup>r</sup> 51	<sup>r</sup> 18,336	<sup>e</sup> 55	<sup>e</sup> 18,399
Combined value of beryllium concentrates, clays (bentonite), lime, mica (scrap), and values indicated by symbol W -----	XX	11,265	XX	<sup>r</sup> 44,800	XX	181,291
Total -----	XX	<sup>r</sup> 198,259	XX	<sup>r</sup> 207,703	XX	232,886

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State—Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>TENNESSEE</b>						
Clays <sup>2</sup> ----- thousand short tons..	1,165	\$21,690	1,244	\$25,913	1,164	\$25,228
Gem stones-----	NA	<sup>e</sup> 5	NA	<sup>e</sup> 5	NA	W
Phosphate rock----- thousand metric tons..	1,368	33,275	1,233	<sup>r</sup> 27,000	1,232	27,000
Sand and gravel:						
Construction----- thousand short tons..	6,304	19,830	<sup>e</sup> 7,200	<sup>e</sup> 22,000	7,360	24,592
Industrial----- do.-----	650	6,903	569	6,156	488	5,523
Stone:						
Crushed----- do.-----	<sup>e</sup> 36,200	<sup>e</sup> 138,000	<sup>e</sup> 37,939	<sup>e</sup> 155,760	<sup>e</sup> 40,700	<sup>e</sup> 175,600
Dimension----- do.-----	<sup>r</sup> <sup>e</sup> 6	<sup>r</sup> <sup>e</sup> 1,849	<sup>r</sup> <sup>e</sup> 6	<sup>r</sup> <sup>e</sup> 1,856	<sup>r</sup> <sup>e</sup> 6	<sup>r</sup> <sup>e</sup> 1,553
Zinc (recoverable content of ores, etc.)----- metric tons..	116,526	124,854	104,471	92,971	102,118	85,550
Combined value of barite, cement, clays (fuller's earth), copper, lead (1984-85), lime, pyrites, silver, stone (crushed granite, 1985-86), and value indicated by symbol W-----	XX	131,918	XX	141,109	XX	136,610
Total-----	XX	<sup>r</sup> 478,324	XX	<sup>r</sup> 472,770	XX	481,656
<b>TEXAS</b>						
Cement:						
Masonry----- thousand short tons..	291	\$24,409	263	\$22,114	209	\$15,790
Portland----- do.-----	10,423	557,421	10,242	532,494	8,883	412,697
Clays----- do.-----	<sup>3</sup> 5,517	<sup>2</sup> 17,091	4,107	25,059	<sup>2</sup> 5,515	<sup>2</sup> 11,724
Gem stones-----	NA	<sup>e</sup> 175	NA	<sup>e</sup> 175	NA	297
Gypsum----- thousand short tons..	2,166	19,431	1,981	17,399	2,131	14,982
Lime----- do.-----	1,157	61,214	1,192	65,927	1,173	62,670
Salt----- do.-----	8,184	69,672	8,390	<sup>r</sup> 84,249	8,520	62,996
Sand and gravel:						
Construction----- do.-----	62,389	199,461	<sup>e</sup> 57,800	<sup>e</sup> 198,000	59,562	209,855
Industrial----- do.-----	2,028	29,282	1,968	29,095	1,302	18,274
Stone:						
Crushed----- do.-----	<sup>e</sup> 89,200	<sup>e</sup> 300,000	85,764	306,821	<sup>e</sup> 84,200	<sup>e</sup> 301,500
Dimension----- do.-----	<sup>r</sup> <sup>e</sup> 46	<sup>r</sup> <sup>e</sup> 14,374	336	<sup>r</sup> 11,209	<sup>e</sup> 49	<sup>e</sup> 15,407
Sulfur (Frasch)----- thousand metric tons..	2,994	W	2,979	W	2,506	W
Talc and pyrophyllite----- thousand short tons..	240	4,125	261	5,245	283	6,456
Combined value of asphalt (native), clays (ball clay, 1986, fuller's earth and kaolin, 1984, 1986), fluorspar, helium (crude and Grade-A), iron ore (usable), magnesium chloride <sup>2</sup> (1984-85), magnesium compounds, magnesium metal <sup>3</sup> (1986), mica (scrap, 1984-85), sodium sulfate (natural), and values indicated by symbol W-----	XX	419,861	XX	435,936	XX	579,340
Total-----	XX	<sup>r</sup> 1,716,516	XX	<sup>r</sup> 1,736,623	XX	1,711,988
<b>UTAH</b>						
Beryllium concentrates----- short tons..	6,030	\$6	5,738	\$6	6,533	\$7
Cement (portland)----- thousand short tons..	W	W	W	W	1,014	58,431
Clays----- do.-----	<sup>3</sup> 15	<sup>2</sup> 2,223	332	2,509	305	2,048
Gem stones-----	NA	<sup>e</sup> 80	NA	<sup>e</sup> 80	NA	96
Gold (recoverable content of ores, etc.)-----	W	W	135,489	43,039	W	W
Gypsum----- troy ounces..	277	2,671	413	4,033	470	3,671
Lime----- thousand short tons..	297	16,471	225	11,912	232	13,079
Salt----- do.-----	1,246	28,651	<sup>r</sup> 1,057	<sup>r</sup> 30,013	1,112	31,830
Sand and gravel:						
Construction----- do.-----	15,217	34,507	<sup>e</sup> 14,000	<sup>e</sup> 36,400	16,452	39,763
Industrial----- do.-----	11	W	W	W	6	123
Stone (crushed)----- do.-----	<sup>e</sup> 5,200	<sup>e</sup> 16,400	4,657	14,180	<sup>e</sup> 4,500	<sup>e</sup> 14,100
Vermiculite----- do.-----	--	--	--	--	W	153
Combined value of asphalt (native), cement (masonry), clays (fuller's earth, 1984), copper, iron ore (usable, 1986), lead (1984), magnesium compounds, magnesium metal <sup>3</sup> (1986), molybdenum (1984-85), phosphate rock, potassium salts, silver, sodium sulfate (natural), stone (dimension), vanadium (1984, 1986), zinc (1984), and values indicated by symbol W-----	XX	<sup>r</sup> 424,491	XX	<sup>r</sup> 171,792	XX	210,755
Total-----	XX	<sup>r</sup> 525,500	XX	<sup>r</sup> 313,964	XX	374,056

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State —Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>VERMONT</b>						
Sand and gravel (construction) thousand short tons...	3,802	\$8,071	*2,700	*\$7,000	4,834	\$11,226
Stone:						
Crushed.....do.....	*1,800	*7,000	1,689	7,468	*1,600	*7,600
Dimension.....do.....	r *111	r *23,963	116	26,346	*105	*27,075
Combined value of asbestos, gem stones, and talc and pyrophyllite.....	XX	9,565	XX	9,040	XX	9,310
Total.....	XX	*48,599	XX	49,854	XX	55,211
<b>VIRGINIA</b>						
Clays..... thousand short tons...	712	\$6,004	814	\$6,977	890	\$7,700
Gem stones.....do.....	NA	*20	NA	*20	NA	20
Iron oxide pigments (crude)..... short tons...	W	W	2,280	W	W	W
Lime..... thousand short tons...	562	24,799	633	28,103	624	27,362
Sand and gravel (construction).....do.....	8,860	37,359	*10,200	*42,000	11,670	46,488
Stone:						
Crushed.....do.....	*47,200	*196,000	51,686	221,900	*52,000	*224,700
Dimension.....do.....	r *10	r *3,066	10	3,136	*10	*3,128
Combined value of aplite, cement, gypsum, kyanite, sand and gravel (industrial), talc and pyrophyllite (1984-85), vermiculite, and values indicated by symbol W.....	XX	74,355	XX	79,140	XX	83,639
Total.....	XX	*341,603	XX	381,276	XX	393,037
<b>WASHINGTON</b>						
Cement:						
Masonry..... thousand short tons...	W	W	W	W	6	\$530
Portland.....do.....	W	W	W	W	1,212	59,091
Clays.....do.....	*292	*1,598	243	\$1,402	252	1,560
Gem stones.....do.....	NA	*200	NA	*200	NA	200
Peat..... thousand short tons...	W	W	12	292	W	W
Sand and gravel:						
Construction.....do.....	23,369	61,070	*22,700	*62,300	26,342	76,387
Industrial.....do.....	356	5,201	322	5,589	W	W
Stone:						
Crushed.....do.....	*10,400	*31,700	9,543	31,052	*9,000	*34,100
Dimension.....do.....	r *1	r *53	1	53	*1	*69
Combined value of barite (1984-85), calcium chloride (natural, 1985-86), clays (fire clay, 1984) diatomite, gold, gypsum, lime, magnesium metal <sup>2</sup> (1986), olivine, silver, talc and pyrophyllite (1984), and values indicated by symbol W.....	XX	102,855	XX	*120,719	XX	204,688
Total.....	XX	*202,677	XX	*221,607	XX	376,625
<b>WEST VIRGINIA</b>						
Clays..... thousand short tons...	381	\$3,410	331	\$3,342	215	\$470
Gem stones.....do.....					NA	1
Salt..... thousand short tons...	1,004	W	895	W	W	W
Sand and gravel (construction).....do.....	976	3,198	*900	*3,000	1,501	5,365
Stone (crushed).....do.....	*9,100	*37,300	9,393	38,348	*9,800	*37,500
Combined value of cement, lime (1984-85), sand and gravel (industrial), and values indicated by symbol W.....	XX	68,279	XX	60,719	XX	86,473
Total.....	XX	112,187	XX	105,409	XX	129,809
<b>WISCONSIN</b>						
Gem stones.....do.....					NA	\$15
Lime..... thousand short tons...	373	\$19,892	341	\$19,001	350	19,715
Peat.....do.....	9	W	10	W	9	W
Sand and gravel:						
Construction.....do.....	17,785	38,245	*16,000	*36,000	24,913	59,325
Industrial.....do.....	1,060	11,821	1,197	14,624	1,194	12,399

See footnotes at end of table.

Table 5.—Nonfuel mineral production<sup>1</sup> in the United States, by State—Continued

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
WISCONSIN—Continued						
Stone:						
Crushed _____ thousand short tons ..	<sup>e</sup> 15,800	<sup>e</sup> \$45,000	14,496	\$42,380	<sup>e</sup> 18,700	<sup>e</sup> \$57,600
Dimension _____ do. ....	<sup>r</sup> <sup>e</sup> 23	<sup>r</sup> <sup>e</sup> 2,651	22	2,733	<sup>e</sup> 23	<sup>e</sup> 2,878
Combined value of abrasives, cement, and values indicated by symbol W .....	XX	11,527	XX	10,372	XX	12,600
Total .....	XX	<sup>r</sup> 129,136	XX	125,110	XX	164,532
WYOMING						
Clays _____ thousand short tons ..	2,628	\$67,921	2,302	\$64,146	1,762	\$51,823
Gem stones .....	NA	225	NA	225	NA	225
Gypsum _____ thousand short tons ..	376	2,618	576	4,483	W	W
Lime _____ do. ....	W	W	W	W	25	1,689
Sand and gravel (construction) _____ do. ....	4,586	13,372	<sup>e</sup> 3,500	<sup>e</sup> 11,000	3,377	10,977
Stone (crushed) _____ do. ....	<sup>e</sup> 1,900	<sup>e</sup> 7,600	<sup>e</sup> 2,030	<sup>e</sup> 7,329	<sup>e</sup> 1,700	<sup>e</sup> 5,900
Combined value of beryllium concentrates (1986), cement (masonry, 1986, and portland), helium (Grade-A, 1986), sodium carbonate (natural), stone (crushed granite, 1985-86), and values indicated by symbol W .....	XX	458,187	XX	465,275	XX	485,480
Total .....	XX	549,923	XX	552,463	XX	556,094

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes certain clays; value included with "Combined value" figure.

<sup>3</sup>Less than 1/2 unit.

<sup>4</sup>Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

<sup>5</sup>Excludes certain stones; value included with "Combined value" figure.

<sup>6</sup>Excludes salt in brines; value included with "Combined value" figure.

<sup>7</sup>Magnesium chloride for magnesium metal reporting discontinued in 1986.

<sup>8</sup>Magnesium metal (refinery production) not reported in 1984 and 1985.

Table 6.—Mineral production<sup>1</sup> in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1984 <sup>e</sup>		1985		1986 <sup>e</sup>	
	Quantity	Value	Quantity	Value	Quantity	Value
American Samoa: Stone .....	NA	NA	( <sup>2</sup> )	1	( <sup>2</sup> )	400
Guam: Stone .....	345	2,280	548	3,731	700	3,300
Virgin Islands: Stone .....	249	2,397	214	2,405	200	1,500

<sup>e</sup>Estimated. NA Not available.

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

<sup>2</sup>Less than 1/2 unit.

Table 7.—Mineral production<sup>1</sup> in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1984		1985		1986	
	Quantity	Value	Quantity	Value	Quantity	Value
Cement (portland) .....	997	87,568	962	72,602	1,132	93,288
Clays .....	128	266	118	264	111	233
Lime .....	35	4,531	23	3,249	24	3,291
Salt .....	--	--	<sup>3</sup> 35	<sup>3</sup> 735	40	880
Sand and gravel (industrial) .....	43	W	--	--	31	624
Stone:						
Crushed .....	<sup>e</sup> 5,813	<sup>e</sup> 27,675	5,493	25,799	<sup>e</sup> 5,400	<sup>e</sup> 26,000
Dimension .....	W	W	W	W	--	--
Total <sup>2</sup> .....	XX	<sup>r</sup> 120,040	XX	<sup>r</sup> 102,649	XX	124,306

<sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

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

<sup>2</sup>Total does not include value of items not available or withheld.

Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>METALS</b>				
<b>Aluminum:</b>				
Ingots, slabs, crude ----- metric tons ..	347,292	\$441,598	209,794	\$282,958
Scrap ----- do ..	374,646	350,669	350,858	333,187
Plates, sheets, bars, etc. ----- do ..	167,874	411,337	180,057	442,681
Castings and forgings ----- do ..	12,403	74,498	6,902	59,979
Aluminum sulfate ----- do ..	5,698	1,178	2,749	1,180
Other aluminum compounds ----- do ..	32,390	27,829	29,486	28,847
Antimony, metals and alloys, crude ----- short tons ..	362	876	595	1,210
Bauxite including bauxite concentrate ----- thousand metric tons ..	56	6,407	69	12,946
Beryllium ----- pounds ..	119,428	6,375	79,556	7,394
Bismuth, metals and alloys ----- do ..	268,669	603	92,906	415
Cadmium metal ----- metric tons ..	86	342	38	188
<b>Chromium:</b>				
Ore and concentrate:				
Exports ----- thousand short tons ..	101	4,600	92	4,143
Reexports ----- do ..	4	670	1	511
Ferrochromium ----- do ..	10	7,688	6	5,693
Cobalt (content) ----- thousand pounds ..	627	7,167	681	4,726
<b>Copper:</b>				
Ore, concentrate, composition metal, unrefined (copper content) ----- metric tons ..	168,024	175,307	194,137	215,931
Scrap ----- do ..	134,300	132,386	136,422	123,138
Refined copper and semimanufactures ----- do ..	1,02,293	454,357	86,645	427,359
Other copper manufactures ----- do ..	7,883	17,522	9,583	20,799
<b>Ferrous alloys not elsewhere listed:</b>				
Ferrophosphorus ----- short tons ..	49,674	5,776	38,377	4,393
Ferrous alloys, n.e.c. ----- do ..	14,498	24,581	10,029	11,561
<b>Gold:</b>				
Ore and base bullion ----- troy ounces ..	1,078,369	334,331	1,440,680	512,065
Bullion, refined ----- do ..	2,888,309	919,433	3,172,239	1,207,733
Iron ore ----- thousand long tons ..	5,033	240,557	4,482	204,738
<b>Iron and steel:</b>				
Pig iron ----- short tons ..	31,614	3,543	47,238	4,442
Iron and steel products (major):				
Steel mill products ----- do ..	929,954	855,078	923,822	856,633
Other steel products ----- do ..	200,387	465,672	167,211	442,960
Iron and steel scrap: Ferrous scrap including rerolling materials, ships, boats, other vessels for scrapping ----- thousand short tons ..	10,191	940,416	11,994	1,081,626
<b>Lead:</b>				
Ore and concentrate ----- metric tons ..	9,987	4,503	4,380	1,491
Pigs, bars, anodes, sheets, etc. ----- do ..	27,344	20,977	12,601	13,997
Scrap ----- do ..	59,949	12,963	58,998	14,921
<b>Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c. ----- short tons ..</b>	40,322	113,600	43,992	122,378
<b>Manganese:</b>				
Ore and concentrate ----- do ..	56,040	4,286	41,966	3,278
Ferromanganese ----- do ..	6,927	4,762	4,323	2,650
Silicomanganese ----- do ..	3,089	1,359	2,004	687
Metal ----- do ..	5,162	7,242	5,146	7,892
<b>Molybdenum:</b>				
Ore and concentrate (molybdenum content) ----- thousand pounds ..	63,859	247,690	49,153	186,006
Metal and alloys, crude and scrap ----- do ..	574	2,365	1,000	3,111
Wire ----- do ..	546	6,130	494	7,671
Semimanufactured forms, n.e.c. ----- do ..	408	3,390	486	9,119
Powder ----- do ..	369	2,298	854	2,821
Ferromolybdenum ----- do ..	1,262	2,698	332	929
Compounds ----- do ..	23,769	46,109	17,063	24,997
<b>Nickel:</b>				
Primary (unwrought commercially pure, anodes, ferronickel, powder and flakes) ----- short tons ..	24,354	96,503	3,083	19,416
Wrought (bars, rods, angles, shapes, sections; plates, sheets, strip; tubes, pipes, blanks, fittings, hollow bar; wire) ----- do ..	8,155	89,289	7,443	69,836
Compound catalysts and waste and scrap ----- do ..	18,920	49,516	12,743	25,643
<b>Platinum-group metals:</b>				
Ore and scrap ----- troy ounces ..	362,384	76,993	368,748	103,332
Palladium, rhodium, iridium, osmiridium, ruthenium, osmium (metal and alloys including scrap) ----- do ..	339,254	56,116	277,772	56,753
Platinum (metal and alloys) ----- do ..	187,013	54,052	104,155	41,722
<b>Rare-earth metals: Ferrocerium and pyrophoric alloys ----- metric tons ..</b>	23	317	29	319
Selenium ----- kilograms ..	154,122	1,431	161,007	1,452
<b>Silicon:</b>				
Ferrosilicon ----- short tons ..	12,969	12,671	11,331	8,306
Silicon carbide, crude and in grains (including reexports) ----- do ..	5,186	7,446	4,254	7,197

See footnotes at end of table.

**Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels  
—Continued**

Mineral	1985		1986		
	Quantity	Value (thousands)	Quantity	Value (thousands)	
<b>METALS—Continued</b>					
<b>Silver:</b>					
Ore, concentrate, waste, sweepings					
Bullion, refined	thousand troy ounces	12,145	\$79,086	15,002	\$85,795
do.	do.	12,611	81,746	10,109	56,785
<b>Tantalum:</b>					
Ore, metal, other forms	thousand pounds	491	19,265	463	15,792
Powder	do.	143	15,188	160	14,172
<b>Tin:</b>					
Ingots, pigs, bars, etc.: Exports	metric tons	1,478	16,744	1,547	9,742
Tinplate and terneplate	do.	155,119	85,000	219,074	91,793
<b>Titanium:</b>					
Ore and concentrate	short tons	27,759	6,953	5,314	1,414
Unwrought and scrap metal	do.	6,992	17,475	6,679	12,870
Intermediate mill shapes and mill products, n.e.c.	do.	3,395	70,423	3,251	70,167
Pigments and oxides	do.	103,201	112,870	115,447	156,335
<b>Tungsten (tungsten content):</b>					
Ore and concentrate	metric tons	124	831	34	242
Carbide powder	do.	661	15,734	349	9,268
Alloy powder	do.	1,449	33,331	951	19,779
<b>Vanadium:</b>					
Ore and concentrate (vanadium content)	thousand pounds	5	9	177	772
Pentoxide, etc.	do.	3,053	6,300	3,068	6,810
Ferrovanadium	do.	908	4,791	1,025	4,647
<b>Zinc:</b>					
Slabs, pigs, or blocks	metric tons	1,011	1,525	1,938	3,533
Sheets, plates, strips, other forms, n.e.c.	do.	776	1,973	721	1,513
Waste, scrap, dust (zinc content)	do.	45,984	22,080	70,211	34,907
Semifabricated forms, n.e.c.	do.	2,677	3,503	2,660	3,356
Ore and concentrate	do.	23,264	8,216	3,269	1,590
<b>Zirconium:</b>					
Ore and concentrate	short tons	18,855	3,965	17,474	4,567
Oxide	do.	1,048	3,332	1,817	4,010
Metals, alloys, other forms	do.	1,153	51,558	1,190	63,134
<b>INDUSTRIAL MINERALS</b>					
<b>Abrasives (includes reexports):</b>					
Industrial diamond, natural or synthetic:					
Powder or dust	thousand carats	51,593	81,806	51,163	89,812
Other	do.	3,291	29,530	3,564	30,313
Diamond grinding wheels	do.	553	6,603	464	5,597
Other natural and manufactured metallic abrasives and products	do.	XX	289,716	XX	210,452
<b>Asbestos:</b>					
Exports:					
Unmanufactured	metric tons	45,075	16,366	46,897	14,401
Products	do.	XX	193,476	XX	162,851
Reexports:					
Unmanufactured	metric tons	581	123	384	119
Products	do.	XX	283	XX	1,045
Barite: Natural barium sulfate	short tons	5,876	692	6,969	1,021
<b>Boron:</b>					
Boric acid	do.	49,457	21,598	42,178	23,562
Sodium borates, refined	do.	623,375	151,000	624,057	161,000
Bromine compounds	thousand pounds	61,000	23,400	28,000	23,900
<b>Calcium:</b>					
Other calcium compounds including precipitated calcium carbonate	short tons	49,000	25,000	26,833	15,000
Chloride	do.	26,143	6,343	18,168	3,962
Dicalcium phosphate	do.	58,600	43,000	51,113	42,000
Cement: Hydraulic and clinker	do.	97,897	21,478	58,556	9,024
<b>Clays:</b>					
Kaolin or china clay	thousand short tons	1,381	174,204	1,583	213,373
Bentonite	do.	640	44,973	581	44,607
Other	do.	759	90,694	749	93,182
Diatomite	do.	120	28,519	131	32,180
Feldspar, leucite, nepheline syenite	short tons	9,280	680	12,000	1,024
Fluorspar	do.	9,671	1,063	16,215	1,801
<b>Gem stones (including reexports):</b>					
Diamond	thousand carats	2,378	571,300	2,527	787,700
Pearls	do.	XX	3,600	XX	2,600
Other	do.	XX	196,400	XX	111,700
Graphite, natural	short tons	28,357	3,125	7,754	3,416
<b>Gypsum:</b>					
Crude, crushed or calcined	thousand short tons	83	13,021	155	15,481
Manufactured, wallboard and plaster articles	do.	XX	13,398	XX	13,324
Helium	million cubic feet	439	25,316	432	16,200

See footnotes at end of table.

Table 8.—U.S. exports of principal minerals and products, excluding mineral fuels  
—Continued

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>INDUSTRIAL MINERALS—Continued</b>				
Lime----- short tons..	19,383	\$5,155	16,448	\$4,500
Lithium compounds:				
Lithium carbonate----- thousand pounds..	13,916	19,006	11,579	15,978
Lithium hydroxide----- do.....	7,853	13,709	6,388	11,141
Other lithium compounds----- do.....	5,608	12,453	3,092	8,060
Magnesium compounds:				
Magnesite, dead-burned----- short tons..	24,805	5,529	23,746	5,488
Magnesite, crude, caustic-calcined, lump or ground. do....	21,567	9,773	22,801	13,295
Mica:				
Waste, scrap, ground----- thousand pounds..	17,378	2,370	14,892	2,230
Block, film, splittings----- do.....	82	159	98	196
Manufactured, cut or stamped, built-up----- do....	NA	5,103	NA	4,502
Mineral-earth pigments, iron oxide, natural and synthetic				
----- short tons..	29,720	27,574	28,841	30,830
Nitrogen compounds (major)----- thousand short tons..	10,799	1,553,387	7,754	NA
Phosphate rock----- thousand metric tons..	9,136	263,631	7,848	211,701
Phosphatic fertilizers:				
Phosphoric acid----- do.....	716	141,162	700	110,010
Superphosphates----- do.....	5,524	176,515	5,223	155,861
Diammonium phosphates----- do.....	6,131	1,048,322	4,120	641,385
Elemental phosphorus----- metric tons..	17,131	27,024	20,266	33,310
Pigments and compounds: Zinc oxide (metal content) do....	359	1,005	791	1,124
Potash:				
Potassium chloride----- do.....	699,770	NA	708,357	NA
Potassium sulfate----- do.....	91,000	NA	155,608	NA
Quartz, crystal:				
Cultured----- thousand pounds..	185	3,723	324	5,686
Natural----- do.....	60	290	74	411
Salt:				
Crude and refined----- thousand short tons..	904	15,988	1,165	16,928
Shipments to noncontiguous territories----- do....	23	5,196	24	6,725
Sand and gravel:				
Construction:				
Sand----- do.....	997	6,212	674	5,446
Gravel----- do.....	516	2,723	492	2,392
Industrial sand----- do.....	866	22,580	849	20,363
Sodium compounds:				
Sodium carbonate----- do.....	1,747	173,937	2,049	241,238
Sodium sulfate----- do.....	119	11,899	111	10,183
Stone:				
Crushed----- do.....	2,372	29,347	2,921	36,967
Dimension----- do.....	NA	13,535	NA	14,623
Sulfur, crude----- thousand metric tons..	1,365	189,248	1,895	251,664
Talc, crude and ground----- thousand short tons..	237	14,282	234	16,302
Total <sup>3</sup> -----	XX	13,080,000	XX	11,558,000

<sup>1</sup>Revised. NA Not available. XX Not applicable.

<sup>2</sup>Not comparable to prior years owing to regrouping of nickel forms.

<sup>3</sup>Silicon carbide (crude and refined) has been deducted and is shown separately elsewhere in this table.

<sup>4</sup>Data may not add to totals shown because of independent rounding.



Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>METALS</b>				
<b>Aluminum:</b>				
Metal ----- metric tons .....	868,674	\$1,017,453	1,348,816	\$1,682,907
Scrap ----- do. ....	127,501	108,625	162,317	141,702
Plates, sheets, bars, etc. ----- do. ....	423,769	847,476	455,531	914,305
Aluminum oxide (alumina) ----- thousand metric tons .....	3,827	735,238	3,603	574,210
<b>Antimony:</b>				
Ore and concentrate (antimony content) ----- short tons .....	6,638	12,381	5,855	5,892
Sulfide including needle or liquated ----- do. ....	167	256	576	596
Metal ----- do. ....	5,129	10,983	7,940	15,242
Oxide ----- do. ....	10,620	20,765	13,521	21,529
<b>Arsenic:</b>				
White (As <sub>2</sub> O <sub>3</sub> content) ----- metric tons .....	16,472	14,059	25,728	16,347
Metallic ----- do. ....	407	2,150	395	2,649
Bauxite, crude and dried ----- thousand metric tons .....	7,158	NA	6,456	NA
Beryllium ore ----- short tons .....	1,646	1,427	1,510	1,324
Bismuth, metals and alloys (gross weight) ----- pounds .....	1,998,865	10,172	2,489,634	6,895
Cadmium metal ----- metric tons .....	1,988	4,122	3,174	6,208
Calcium metal ----- metric tons .....	492,244	1,895	566,170	1,310
Cesium compounds and chloride ----- pounds .....	50,537	1,581	37,487	1,161
<b>Chromium:</b>				
Ore and concentrate (Cr <sub>2</sub> O <sub>3</sub> content) ----- thousand short tons .....	176	20,170	214	21,657
Ferrochromium (gross weight) ----- do. ....	331	156,748	388	172,694
Ferrochromium-silicon ----- do. ....	4	2,085	9	5,743
Metal ----- do. ....	4	19,615	4	21,647
<b>Cobalt:</b>				
Metal ----- thousand pounds .....	16,613	181,379	11,669	83,295
Oxide (gross weight) ----- do. ....	246	2,258	511	4,202
Salts and compounds (gross weight) ----- do. ....	1,413	4,431	805	2,669
Columbium ore ----- do. ....	2,899	4,673	2,854	4,541
<b>Copper (copper content):</b>				
Ore and concentrate ----- metric tons .....	2,869	1,739	4,232	2,593
Matte ----- do. ....	3,997	6,997	702	573
Blister ----- do. ....	12,979	15,529	34,545	60,236
Refined in ingots, etc ----- do. ....	377,725	491,798	501,984	677,010
Scrap ----- do. ....	23,014	25,680	27,216	31,646
<b>Ferroalloys not elsewhere listed, including spiegeleisen</b>				
----- short tons .....	5,096	25,019	3,896	18,588
Gallium ----- kilograms .....	7,961	3,447	17,202	6,954
Germanium ----- do. ....	14,841	8,829	12,911	7,526
<b>Gold:</b>				
Ore and base bullion ----- troy ounces .....	1,865,022	587,002	1,948,996	677,337
Bullion, refined ----- do. ....	6,360,977	2,109,475	13,800,451	5,016,558
Hafnium ----- short tons .....	1	185	1	76
Indium ----- thousand troy ounces .....	980	3,480	1,380	4,633
Iron ore (usable) ----- thousand long tons .....	15,771	452,267	16,743	460,643
<b>Iron and steel:</b>				
Fig iron ----- short tons .....	338,258	50,619	294,967	42,482
Iron and steel products (major): ----- do. ....	24,278,482	9,565,642	20,515,304	7,984,816
Steel mill products ----- do. ....	1,211,146	1,308,921	1,157,893	1,211,251
Other products ----- do. ....	611	46,480	724	49,073
Scrap including tinplate ----- thousand short tons .....				
<b>Lead:</b>				
Ore, flue dust, matte (lead content) ----- metric tons .....	2,649	979	4,604	1,344
Base bullion (lead content) ----- do. ....	760	398	142	114
Pigs and bars (lead content) ----- do. ....	131,353	59,864	140,221	59,172
Reclaimed scrap, etc. (lead content) ----- do. ....	3,168	1,212	3,290	1,471
Sheets, pipes, shot ----- do. ....	1,981	2,517	1,344	1,825
<b>Magnesium:</b>				
Metal and scrap ----- short tons .....	4,866	10,303	5,191	12,007
Alloys (magnesium content) ----- do. ....	3,651	12,774	1,808	7,008
Sheets, tubing, ribbons, wire, other forms (magnesium content) ----- do. ....	754	2,010	2,210	5,556
<b>Manganese:</b>				
Ore (35% or more contained manganese) ----- do. ....	386,859	22,561	463,242	23,122
Ferromanganese ----- do. ....	366,374	104,389	395,650	120,482
Ferrosilicon-manganese (manganese content) ----- do. ....	109,719	51,423	131,425	58,839
Metal ----- do. ....	8,566	9,052	9,668	9,800
<b>Mercury:</b>				
Compounds ----- pounds .....	329,889	1,625	316,224	1,395
Metal ----- 76-pound flasks .....	18,890	5,337	20,187	4,176

See footnotes at end of table.

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

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS —Continued				
Molybdenum:				
Ore and concentrate (molybdenum content)				
pounds	112	\$566	1,120	\$3,057
Waste and scrap (gross weight)	NA	2,830	NA	2,870
Metal:				
Unwrought (molybdenum content)	145	2,370	191	2,510
Wrought (gross weight)	94	2,301	102	2,701
Ferromolybdenum (gross weight)	1,424	3,721	1,599	3,626
Material in chief value molybdenum (molybdenum content)	2,239	7,329	1,102	3,284
Compounds (gross weight)	3,815	6,678	4,650	9,091
Nickel:				
Pigs, ingots, shot, cathodes	97,779	446,009	99,017	407,210
Plates, bars, etc	10,100	89,660	6,590	53,894
Slurry	68,210	101,101	9,170	19,281
Scrap	5,552	16,430	6,795	19,581
Powder and flakes	12,753	67,717	10,342	51,051
Ferronickel	36,528	60,253	37,901	53,672
Oxide	5,079	20,722	2,868	4,372
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum)	20,827	6,807	10,465	4,758
Sponge (platinum)	1,464,645	542,133	1,713,971	780,382
Sweepings, waste, scrap	530,724	62,342	737,813	95,466
Iridium	20,972	9,615	30,368	13,517
Palladium	1,396,810	174,333	1,387,131	174,856
Rhodium	201,028	173,310	179,068	195,666
Ruthenium	162,887	16,474	176,580	13,649
Other platinum-group metals	15,701	4,707	32,010	9,217
Semimanufactured:				
Platinum	78,206	23,946	94,655	44,766
Palladium	84,492	9,532	114,596	14,376
Rhodium	145	73	1	3
Other platinum-group metals	13,157	2,422	519	59
Rare-earth metals:				
Ferrocerium and other cerium alloys	113,385	1,302	95,262	1,154
Monazite	5,694	1,984	2,960	1,106
Metals including scandium and yttrium	3,185	285	19,558	1,837
Rhenium:				
Metal including scrap	4,943	1,225	5,495	2,617
Ammonium perchlenate (rhenium content)	3,325	669	12,188	2,149
Selenium and selenium compounds (selenium content)				
kilograms	400,658	8,358	462,646	9,550
Silicon:				
Metal (over 96% silicon content)	51,801	83,367	40,852	65,180
Ferrosilicon	155,421	74,019	223,031	100,578
Silver:				
Ore and base bullion	3,533	20,180	5,516	30,926
Bullion, refined	137,398	855,550	125,365	688,296
Sweepings, waste, doré	11,671	76,218	14,008	78,962
Tantalum ore	737	8,187	905	7,713
Tellurium (tellurium content)	30,050	871	13,935	911
Thallium	2,655	50	5,302	358
Tin:				
Concentrate (tin content)	1,616	10,640	3,936	13,693
Dross, skimmings, scrap, residue, tin alloys, n.s.p.f.				
do	877	2,804	1,121	1,899
Tin foil, powder, flitters, etc	XX	3,290	XX	1,280
Tin compounds	827	5,164	860	5,165
Titanium:				
Ilmenite <sup>2</sup>	798,632	66,821	827,489	81,563
Rutile	179,663	43,967	174,820	52,214
Metal	5,479	39,408	5,346	36,097
Ferrotitanium and ferrosilicon titanium	483	982	681	1,421
Pigments	196,213	206,809	202,674	240,058
Tungsten ore and concentrate (tungsten content)				
metric tons	4,746	36,706	2,522	13,840
Vanadium (vanadium content):				
Ferrovanadium	1,557	7,757	1,189	6,423
Pentoxide	22	180	824	3,564
Vanadium-bearing materials	605	535	4,027	5,720

See footnotes at end of table.

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

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS—Continued				
Zinc:				
Ore and concentrates (zinc content) — metric tons ..	90,186	\$33,626	75,786	\$19,096
Blocks, pigs, slabs .. do ..	610,900	508,003	665,126	487,030
Sheets, etc. .... do ..	3,559	2,757	3,811	3,048
Fume (zinc content) .. do ..	—	—	11	2
Waste and scrap .. do ..	3,247	1,848	4,521	1,937
Dross and skimmings .. do ..	4,942	2,419	6,087	3,098
Dust, powder, flakes .. do ..	8,681	10,781	7,446	8,260
Manufactured .. do ..	XX	713	XX	1,206
Zirconium:				
Ore including zirconium sand .. short tons ..	43,787	4,599	75,799	7,836
Metal, scrap, compounds .. do ..	4,202	24,962	3,616	18,974
INDUSTRIAL MINERALS				
Abrasives:				
Diamond (industrial) .. thousand carats ..	46,222	127,191	45,991	110,648
Other .. do ..	XX	255,686	XX	294,125
Asbestos .. metric tons ..	142,431	44,093	108,332	26,537
Barite:				
Crude and ground .. thousand short tons ..	2,127	82,913	767	28,858
Witherite .. short tons ..	142	74	147	78
Chemicals .. do ..	32,907	19,978	31,603	21,733
Boron:				
Boric acid (contained boron oxide) .. do ..	6,000	5,121	3,000	3,824
Colemanite (contained boron oxide) .. thousand short tons ..	33,000	24,620	16,000	8,770
Ulexite .. do ..	31,000	11,120	42,000	17,766
Bromine (contained in compounds) .. thousand pounds ..	17,079	11,065	18,815	9,734
Calcium chloride:				
Crude .. short tons ..	75,381	9,059	143,328	14,403
Other .. do ..	2,355	1,908	2,098	1,264
Cement: Hydraulic and clinker .. thousand short tons ..	14,487	437,429	16,319	468,993
Clays .. short tons ..	40,902	5,981	38,398	7,501
Yrrolite .. do ..	16,596	10,003	11,344	6,959
Feldspar:				
Crude .. do ..	936	1,126	568	474
Ground and crushed .. do ..	16	25	683	68
Fluorspar .. do ..	552,959	49,639	552,785	45,675
Gem stones:				
Diamond .. thousand carats ..	8,151	3,006,762	9,192	3,459,931
Emeralds .. do ..	2,741	139,000	2,757	152,396
Other .. do ..	XX	534,113	XX	566,325
Graphite, natural .. short tons ..	52,737	16,186	42,790	15,758
Gypsum:				
Crude, ground, calcined .. thousand short tons ..	9,924	64,331	9,562	65,432
Manufactured .. do ..	XX	91,091	XX	115,735
Iodine, crude .. thousand pounds ..	4,971	26,761	3,023	17,199
Lime:				
Hydrated .. short tons ..	48,827	3,407	57,842	4,108
Other .. do ..	145,230	8,810	142,865	8,129
Lithium:				
Ore .. do ..	4,716	1,277	13,327	3,616
Compounds .. do ..	1,402	5,774	2,095	9,166
Magnesium compounds:				
Crude magnesite .. do ..	1,350	332	37	15
Lump or ground caustic-calcined magnesia .. do ..	65,709	10,407	78,742	11,493
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite .. do ..	179,207	32,075	213,135	38,906
Compounds .. do ..	36,751	10,085	39,807	11,038
Mica:				
Waste, scrap, ground .. thousand pounds ..	20,057	2,920	21,962	3,549
Block, film, splittings .. do ..	1,684	1,080	1,867	654
Manufactured, cut or stamped, built-up .. do ..	978	3,154	2,106	4,859
Mineral-earth pigments, iron oxide:				
Other, crude and refined .. short tons ..	26	22	604	78
Siennas, crude and refined .. do ..	270	49	144	73
Umber, crude and refined .. do ..	4,921	795	5,855	1,071
Vandyke brown .. do ..	404	140	572	293
Other natural and refined .. do ..	1,026	561	845	619
Synthetic .. do ..	33,151	20,999	28,754	19,382
Nepheline syenite:				
Crude .. do ..	920	62	2,970	205
Ground, crushed, etc .. do ..	331,684	11,373	295,836	11,075
Nitrogen compounds (major) including urea .. thousand short tons ..	8,544	880,348	7,903	777,906

See footnotes at end of table.

**Table 9.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued**

Mineral	1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>INDUSTRIAL MINERALS —Continued</b>				
Peat:				
Fertilizer-grade short tons	452,018	\$54,244	540,729	\$68,054
Poultry- and stable-grade do	25,370	3,606	12,367	1,452
Phosphates, crude and apatite thousand metric tons	34	1,593	528	22,265
Phosphatic fertilizers:				
Fertilizer and fertilizer materials do	30	5,929	69	8,351
Elemental phosphorus do	2	3,530	2	3,548
Other do	3	492	2	473
Pigments and salts:				
Lead pigments and compounds metric tons	16,272	12,468	21,270	12,932
Zinc pigments and compounds do	52,310	48,244	57,317	47,006
Potash do	7,570,900	499,100	6,933,800	385,100
Pumice:				
Crude or unmanufactured short tons	781	198	3,488	297
Wholly or partly manufactured do	357	103	509	204
Manufactured, n.s.p.f. do	XX	218	XX	512
Quartz crystal (Brazilian lascas) thousand pounds	173	99	52	51
Salt thousand short tons	6,207	65,593	6,665	79,709
Sand and gravel:				
Industrial sand do	81	1,513	88	1,014
Other sand and gravel do	246	1,572	205	1,412
Sodium compounds:				
Sodium carbonate do	56	8,089	106	15,023
Sodium sulfate do	195	14,492	188	13,829
Stone:				
Crushed do	2,725	10,209	2,864	10,902
Dimension do	XX	294,246	XX	379,724
Calcium carbonate fines thousand short tons	281	1,432	351	1,548
Strontium:				
Minerals short tons	37,552	3,321	33,236	3,396
Compounds do	7,458	5,713	8,495	5,871
Sulfur and compounds, sulfur ore and other forms, n.e.s. thousand metric tons	2,104	199,240	1,347	142,220
Talc, unmanufactured thousand short tons	47	9,532	52	8,715
<b>Total<sup>3</sup></b>	<b>XX</b>	<b>29,380,000</b>	<b>XX</b>	<b>31,693,000</b>

<sup>1</sup>Revised. NA Not available. XX Not applicable.

<sup>2</sup>Less than 1/2 unit.

<sup>3</sup>Includes titanium slag averaging about 70% TiO<sub>2</sub>. For details, see "Titanium" chapter.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities**

(Thousand short tons unless otherwise specified)

Mineral	1985			1986 <sup>P</sup>		
	World production <sup>1</sup>	U.S. production	U.S. percent of world production	World production <sup>1</sup>	U.S. production	U.S. percent of world production
<b>METALS, MINE BASIS</b>						
Antimony (content of ore and concentrate) short tons	61,833	W	NA	66,020	W	NA
Arsenic trioxide <sup>2</sup> metric tons	54,731	2,200	4	55,456	--	--
Bauxite <sup>3</sup> thousand metric tons	84,310	674	1	85,388	510	1
Beryl short tons	3,973	3,738	64	9,874	6,533	66
Bismuth thousand pounds	10,498	W	NA	8,965	W	NA
Chromite	11,630	--	--	11,394	--	--
Cobalt (content of ore and concentrate) thousand pounds	80,229	--	--	79,700	--	--
Columbium-tantalum concentrate (gross weight) do	84,184	--	--	78,876	--	--
Copper (content of ore and concentrate) thousand metric tons	8,088	1,106	14	8,156	1,147	14

See footnotes at end of table.

Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities—Continued

(Thousand short tons unless otherwise specified)

Mineral	1985			1986 <sup>P</sup>		
	World production <sup>1</sup>	U.S. production	U.S. percent of world production	World production <sup>1</sup>	U.S. production	U.S. percent of world production
<b>METALS, MINE BASIS—Continued</b>						
Gold (content of ore and concentrate) thousand troy ounces	48,673	2,427	5	50,937	3,733	7
Iron ore (gross weight) thousand long tons	839,865	48,751	6	847,775	38,825	5
Lead (content of ore and concentrate) thousand metric tons	3,389	424	13	3,239	353	11
Mercury (gross weight) thousand 76-pound flasks	26,912	17	9	26,716	W	NA
Molybdenum (content of ore and concentrate) thousand pounds	216,364	108,409	50	206,192	93,976	46
Nickel (content of ore and concentrate)	884	6	1	864	1	(*)
Platinum-group metals <sup>2</sup> thousand troy ounces	7,938	W	NA	7,334	W	NA
Silver (content of ore and concentrate) do.	421,041	39,433	9	419,781	34,220	8
Tin (content of ore and concentrate) metric tons	188,653	W	NA	180,237	W	NA
Titanium concentrates (gross weight): Ilmenite	3,793	W	NA	3,750	W	NA
Rutile	414	W	NA	439	W	NA
Tungsten ore and concentrate (contained tungsten) metric tons	46,535	996	2	42,474	780	2
Vanadium (content of ore and concentrate) short tons	33,299	W	NA	32,800	W	NA
Zinc (content of ore and concentrate) thousand metric tons	6,857	252	4	6,853	216	3
<b>METALS, SMELTER BASIS</b>						
Aluminum (primary only) do.	15,351	3,500	23	15,314	3,037	20
Cadmium metric tons	18,634	1,603	9	18,257	1,486	8
Cobalt short tons	57,981	—	—	60,645	—	—
Copper smelter (primary and secondary) <sup>5</sup> thousand metric tons	8,585	1,191	14	8,554	1,196	14
Iron, pig (shipments)	555,416	49,963	9	546,833	44,287	8
Lead, smelter (primary and secondary) <sup>6</sup> thousand metric tons	5,587	1,103	20	5,413	981	18
Magnesium (primary)	362	150	41	359	138	38
Nickel <sup>7</sup>	807	36	4	810	2	(*)
Selenium <sup>8</sup> kilograms	1,175,868	W	NA	1,073,984	W	NA
Steel, raw	790,036	<sup>9</sup> 88,259	11	780,966	<sup>9</sup> 81,606	10
Tellurium <sup>8</sup> kilograms	97,007	W	NA	85,815	W	NA
Tin metric tons	196,633	<sup>10</sup> 9,000	2	189,933	<sup>10</sup> 3,213	2
Zinc (primary and secondary) thousand metric tons	6,894	334	5	6,784	316	5
<b>INDUSTRIAL MINERALS</b>						
Asbestos do.	4,678	57	1	4,522	51	1
Barite	6,597	<sup>11</sup> 739	11	5,404	<sup>11</sup> 297	5
Boron minerals	3,383	1,269	38	3,534	1,251	35
Bromine thousand pounds	839,982	<sup>11</sup> 320,000	38	817,080	<sup>11</sup> 310,000	38
Cement, hydraulic	1,055,738	<sup>12</sup> 78,859	7	1,099,894	<sup>12</sup> 79,916	7
Clays:						
Bentonite <sup>2</sup>	9,592	<sup>11</sup> 3,195	33	9,241	<sup>11</sup> 2,813	30
Fuller's earth <sup>8</sup>	2,612	<sup>12</sup> 2,059	79	2,436	<sup>11</sup> 1,910	78
Kaolin <sup>2</sup>	24,594	<sup>11</sup> 7,793	32	24,933	<sup>11</sup> 8,549	34
Corundum short tons	10,204	—	—	10,160	—	—
Diamond thousand carats	65,603	—	—	91,833	—	—
Diatomite	2,003	635	32	1,972	628	32
Feldspar	4,496	700	16	4,631	735	16
Fluorspar	5,372	66	1	5,367	78	1
Graphite short tons	672,609	—	—	672,837	—	—
Gypsum	93,839	14,726	16	96,556	15,789	16
Iodine, crude thousand pounds	28,015	W	NA	28,333	W	NA
Lime	123,496	<sup>11</sup> 12,713	13	121,831	<sup>11</sup> 12,498	12
Magnesite	15,727	W	NA	13,615	W	NA
Mica (including scrap and ground) thousand pounds	557,649	275,100	49	579,146	296,300	51
Nitrogen, N content of ammonia	96,978	13,238	14	95,946	11,499	12
Peat	266,304	839	(*)	271,839	886	(*)

See footnotes at end of table.

Table 10.—Comparison of world and U.S. production of selected nonfuel mineral commodities —Continued

(Thousand short tons unless otherwise specified)

Mineral	1985			1986 <sup>P</sup>		
	World production <sup>1</sup>	U.S. production	U.S. percent of world production	World production <sup>1</sup>	U.S. production	U.S. percent of world production
<b>INDUSTRIAL MINERALS —Continued</b>						
Perlite -----	1,802	<sup>11</sup> 518	29	1,798	<sup>11</sup> 507	28
Phosphate rock (gross weight)						
thousand metric tons ..	146,664	50,835	35	137,063	38,710	28
Potash (K <sub>2</sub> O equivalent) ----- do.---	29,051	1,296	4	28,248	1,202	4
Pumice <sup>8</sup> -----	12,085	<sup>11</sup> 508	4	11,520	<sup>11</sup> 554	5
Salt -----	191,565	<sup>11</sup> 1240,102	21	192,222	<sup>11</sup> 1236,703	19
Sodium compounds, natural and manufactured:						
Sodium carbonate -----	31,129	8,511	27	31,363	8,438	27
Sodium sulfate -----	4,838	835	17	4,738	798	17
Strontium <sup>9</sup> ----- short tons ..	182,401	--	--	183,044	--	--
Sulfur, all forms						
thousand metric tons ..	54,587	11,609	21	54,161	11,087	20
Talc and pyrophyllite -----	8,661	1,269	15	8,529	1,302	15
Vermiculite <sup>8</sup> -----	556	<sup>11</sup> 314	56	570	<sup>11</sup> 317	56

<sup>P</sup>Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

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

<sup>2</sup>World total does not include an estimate for output in China.

<sup>3</sup>U.S. figures represent dried bauxite equivalent of crude ore; to the extent possible, individual country figures that are included in the world total are also on the dried bauxite equivalent basis, but for some countries, available data are insufficient to permit this adjustment.

<sup>4</sup>Less than 0.5%.

<sup>5</sup>Primary and secondary blister and anode copper, including electrowon refined copper that is not included as blister or anode.

<sup>6</sup>Includes bullion.

<sup>7</sup>Refined nickel plus nickel content of ferronickel and nickel oxide.

<sup>8</sup>World total does not include estimates for output in the U.S.S.R. or China.

<sup>9</sup>Data from American Iron and Steel Institute. Excludes production of castings by companies that do not report steel ingot.

<sup>10</sup>Includes tin content of alloys made directly from ore.

<sup>11</sup>Quantity sold or used by producers.

<sup>12</sup>Includes Puerto Rico.



# The Mineral Industry of Alabama

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

By James R. Boyle<sup>1</sup> and Ernest A. Mancini<sup>2</sup>

The value of Alabama's nonfuel mineral production in 1986 was \$405.2 million, a slight decrease from that of 1985.

Alabama was second in the Nation in production of bauxite, crushed marble, and ferroalloys; third in fire clay; fifth in

masonry cement and lime; sixth in total clays; and seventh in recovered sulfur. Alabama ranked 19th nationally in value of nonfuel minerals produced. Cement, clays, lime, sand and gravel, and stone were the major commodities produced.

Table 1.—Nonfuel mineral production in Alabama<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons..	259	\$17,247	268	\$18,113	267	\$18,165
Portland ----- do. ....	3,656	167,191	3,721	165,972	3,477	153,629
Clays <sup>2</sup> ----- do. ....	1,906	30,500	1,873	13,139	2,077	14,828
Gem stones ----- do. ....	NA	<sup>e</sup> 1	NA	<sup>e</sup> 1	NA	1
Lime ----- thousand short tons..	1,163	50,560	1,216	52,295	1,180	50,377
Sand and gravel:						
Construction ----- do. ....	10,348	26,188	<sup>e</sup> 11,000	<sup>e</sup> 32,000	10,781	30,807
Industrial ----- do. ....	442	3,600	524	4,533	433	3,388
Stone:						
Crushed ----- do. ....	<sup>e</sup> 22,000	<sup>e</sup> 98,500	25,853	109,176	<sup>e</sup> 24,000	<sup>e</sup> 120,500
Dimension ----- do. ....	<sup>r</sup> <sup>e</sup> 9	<sup>r</sup> <sup>e</sup> 2,231	<sup>r</sup> <sup>1</sup> 0	<sup>r</sup> <sup>2</sup> 661	<sup>e</sup> 8	<sup>e</sup> 968
Combined value of bauxite, clays (bentonite), and salt	XX	13,380	XX	<sup>r</sup> 8,719	XX	12,553
Total -----	XX	<sup>r</sup> 409,398	XX	<sup>r</sup> 406,609	XX	405,216

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. XX Not applicable.

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

<sup>2</sup>Excludes bentonite; value included with "Combined value" figure.



Table 2.—Nonfuel minerals produced in Alabama in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Baldwin	Clays.
Barbour	Clays, bauxite.
Bibb	Clays.
Blount	Cement, stone (dimension).
Calhoun	Stone (crushed), clays.
Chilton	Clays.
Colbert	Stone (crushed).
Coosa	Do.
Dallas	Sand (industrial), clays.
De Kalb	Stone (crushed).
Elmore	Clays.
Etowah	Stone (crushed).
Franklin	Stone (dimension), stone (crushed).
Jackson	Stone (crushed).
Jefferson	Cement, stone (crushed), clays.
Lawrence	Stone (crushed).
Lee	Do.
Lowndes	Clays.
Macon	Sand (industrial).
Madison	Stone (crushed), clays.
Marengo	Cement, stone (crushed).
Marshall	Stone (crushed), clays.
Mobile	Cement, sand (industrial).
Monroe	Stone (crushed).
Montgomery	Sand and gravel (industrial).
Morgan	Stone (crushed).
Randolph	Do.
Russell	Clays.
St. Clair	Cement, stone (crushed), clays.
Shelby	Cement, stone (crushed), lime, clays.
Sumter	Clays, stone (crushed).
Talladega	Stone (crushed), stone (dimension).
Tuscaloosa	Sand (industrial).
Walker	Clays.
Washington	Salt.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—The economic recovery that stimulated the minerals industry in 1985 eased off during 1986. The single-digit unemployment rate increased to over 10% by midyear and ended the year at 9.5%. The mining, manufacturing, and primary metals sectors remained weak as construction activities increased slightly. The State Highway Department's plans to expend nearly \$2 billion over the next 5 years will aid employment for both the minerals industry and the construction industry.

The Tennessee-Tombigbee Waterway handled 3.6 million short tons of cargo in 1986, more than twice that handled in 1985. Leading mineral commodities were coal, crushed stone, and fuel. Crushed stone was being shipped from Kentucky into stone shortage areas along the waterway.

The Alabama State Docks at the Port of Mobile handled 26.7 million short tons of cargo in 1986, compared with 27.7 million tons in 1985. The bulk handling facilities at the dock handled major tonnages of mineral commodities. Minerals imported from foreign sources for use throughout the region were cement (550,000 tons), gypsum (100,000 tons), gravel (570,000 tons), il-

menite (230,000 tons), iron ore (1,230,000 tons), manganese (25,000 tons), potash (130,000 tons), rutile (12,000 tons), salt (1,300 tons), sand (97,000 tons), shell (250,000 tons), and zircon (3,000 tons). Total iron ore imported, including tonnage through private facilities, was nearly 2.5 million long tons.

The State and the U.S. Corps of Engineers signed a cost-sharing agreement on a multimillion-dollar program to deepen Mobile's shipping channel from 40 to 45 feet and to widen it to 400 feet. This will permit larger ships to use the port, primarily for export of coal. Cost of the 3-year venture will be nearly \$61 million.

The Department of Industrial Relations reported that coal production for fiscal year 1986 decreased to 25.3 million short tons. Of the coal operations, 19 were underground and 120 were surface mines; tonnage was nearly equally divided between surface and underground mines. Eight mines produced in excess of 1 million tons; all were underground.

The Alabama Development Office (ADO) announced that capital investments on new and expanding industries increased slightly from \$1.2 billion in 1985 to \$1.3 billion in

Table 3.—Indicators of Alabama business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	3,992	4,022	4,052
Total civilian labor force	do	1,792	1,802	1,883
Unemployment	percent	11.1	8.9	9.8
<b>Employment (nonagricultural):</b>				
Mining total	thousands	14.2	14.5	12.4
Nonmetallic minerals except fuels <sup>1</sup>	do	2.3	2.4	2.3
Coal mining	do	9.8	10.1	8.7
Manufacturing total	do	359.8	358.1	357.5
Primary metal industries	do	26.5	26.6	24.7
Stone, clay, and glass products	do	8.9	9.2	9.5
Chemicals and allied products	do	11.9	11.7	11.2
Petroleum and coal products <sup>1</sup>	do	1.4	1.5	1.5
Construction	do	64.8	71.4	75.4
Transportation and public utilities	do	72.1	72.7	71.5
Wholesale and retail trade	do	291.3	305.6	320.4
Finance, insurance, real estate	do	62.8	65.8	69.0
Services	do	229.3	243.1	258.2
Government and government enterprises	do	293.4	295.9	297.0
Total	do	1,387.7	1,427.1	1,461.4
<b>Personal income:</b>				
Total	millions	\$40,377	\$43,277	\$45,939
Per capita	do	\$10,115	\$10,760	\$11,336
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do	41.0	40.8	41.1
Mining	do	42.6	43.0	40.6
Total average hourly earnings, production workers	do	\$8.0	\$8.5	\$8.6
Mining	do	\$13.2	\$13.7	\$14.0
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$751	\$694	\$746
Nonfarm	do	\$28,433	\$30,735	\$32,655
Mining total	do	\$533	\$591	\$534
Nonmetallic minerals except fuels	do	\$56	\$53	\$54
Coal mining	do	\$396	\$433	\$385
Oil and gas extraction	do	\$80	\$100	\$94
Manufacturing total	do	\$7,533	\$7,852	\$8,197
Primary metal industries	do	\$799	\$821	\$819
Stone, clay, and glass products	do	\$199	\$211	\$222
Chemicals and allied products	do	\$377	\$393	\$393
Petroleum and coal products	do	\$51	\$51	\$55
Construction	do	\$1,568	\$1,775	\$1,902
Transportation and public utilities	do	\$2,192	\$2,217	\$2,262
Wholesale and retail trade	do	\$4,276	\$4,722	\$5,064
Finance, insurance, real estate	do	\$1,285	\$1,433	\$1,622
Services	do	\$4,939	\$5,600	\$6,253
Government and government enterprises	do	\$5,856	\$6,401	\$6,668
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup>	do	15,358	17,237	19,180
Value of nonresidential construction <sup>3</sup>	millions	\$746.9	\$655.4	\$836.8
Value of State road contract awards <sup>4</sup>	do	\$290.7	\$304.2	\$537.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,298	1,406	1,414
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$409.4	\$406.6	\$405.2
Value per capita	do	\$103	\$101	\$100

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

1986. In the mineral-related sector, mining and quarrying of nonmetallic minerals had 4 new operations and 6 expansions totaling \$3.8 million; stone, clay, glass, and concrete products had 3 new operations and 42 expansions totaling \$92.4 million; and primary metals had 1 new operation and 40 expansions totaling \$56.5 million.

**Legislation and Government Programs.**—The Geological Survey of Ala-

bama's (GSA) programs included assessment of the mineral, energy, and water resources of the State to determine their quality, character, and capacity for development. GSA provided resource information and evaluation to other State agencies to assist in development of baseline data for sound regulatory decisions. During the year, 36 reports were published.

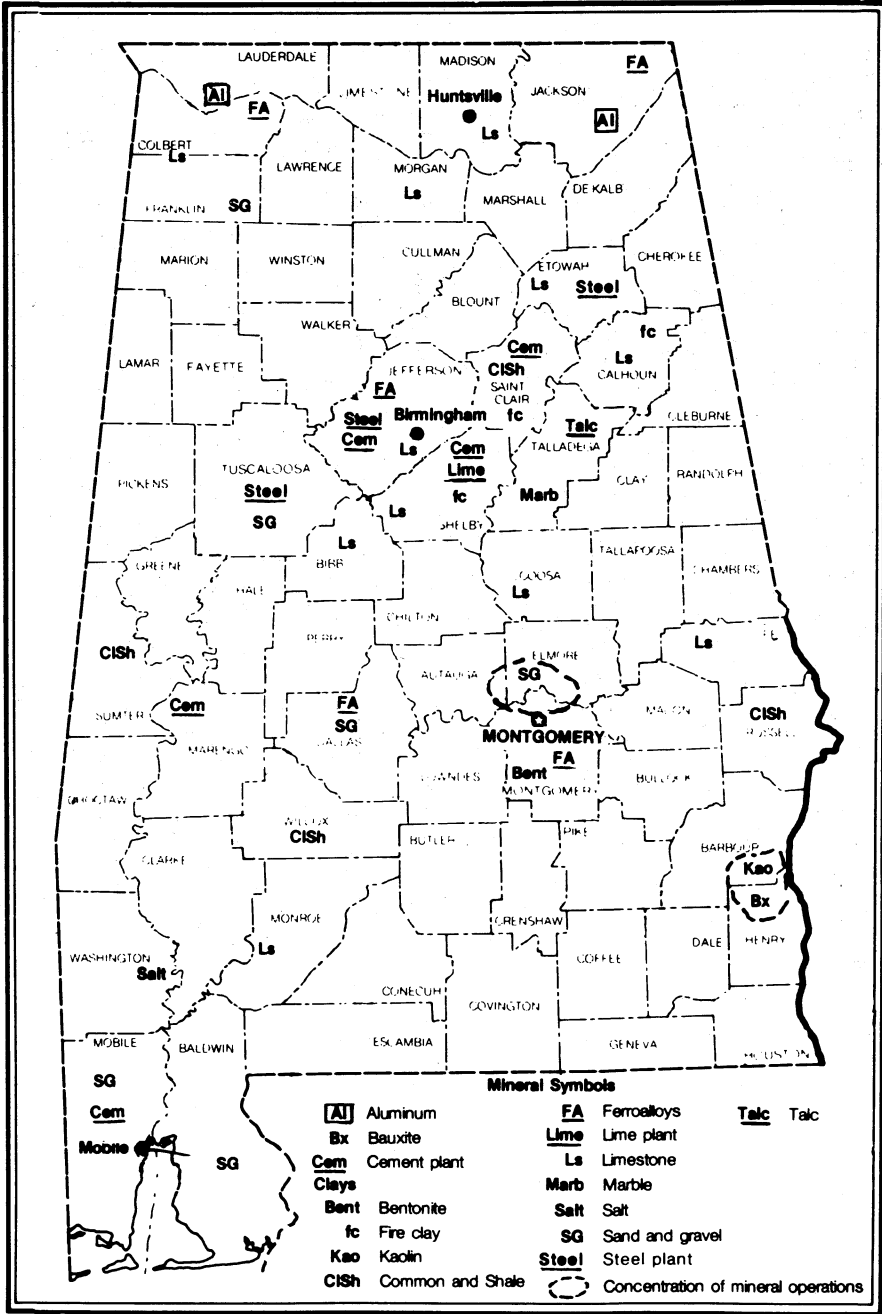


Figure 1.—Principal mineral-producing localities in Alabama.

Water resource investigations continued on watersheds in the Warrior Coalfield, potential saltwater encroachment in coastal Alabama, and the effects of coalbed methane development on water supplies. Mineral resource reports were published on chromite, kyanite, and mineral resources in southwestern Alabama, and studies were undertaken on coal underclays, gold, and tripoli. The Energy Resources Division published a directory of underground coal mines and a report on the energy resources of northwestern Alabama. The Environmental Geology Division collected baseline biological, sediment, and water-quality data concerning the effects of surface mining and methane gas production on aquatic ecosystems in the Warrior Coalfield. Field mapping for a new State geologic map was scheduled to be completed early in 1987.

The issue of offshore oil and gas revenues from Federal leases to be shared with Alabama and other coastal States under section 8(g) of the Outer Continental Shelf Land Act of 1978 was settled early in 1986. Legislation was signed giving coastal States 27% of all revenues earned in the zone adjacent to their borders from September 1978 to October 1986. Distribution of income earned after October 1986 will be determined on the basis of the portion of a Federal tract actually within the zone. Alabama's initial share was \$66 million.

The Mineral Resources Institute (MRI) of the University of Alabama at Tuscaloosa received partial funding from the U.S. Bureau of Mines during fiscal year 1986 to encourage the training of mining engineers and other scientists involved in mineral-related studies and to continue research in mineral exploration, mining, processing, utilization, and conservation. Primary emphases were on energy-related projects, but nonfuel research was conducted on metallic and nonmetallic mineral resources. During

fiscal year 1986, MRI initiated basic clay testing work, previously performed by the Bureau of Mines.

The responsibility of the State Lands Division of the Department of Conservation and Natural Resources was to manage State lands not being used for specific purposes. The division had two major nonfuel leases, one in waterways of southern Alabama and one on the Tennessee River. In fiscal year 1985, royalty receipts totaled nearly \$3 million, down from \$4.7 million in fiscal year 1984. The sources of receipts were \$2.1 million from oil and gas, \$347,000 from coal, \$270,000 from sand and gravel, and \$50,000 from shell. The balance was from permits, miscellaneous fees, and easements.

The U.S. Bureau of Mines Tuscaloosa Research Center conducted several mineral-related projects in Alabama. Results from their research and other pertinent Bureau research included Report of Investigations (RI) 9004, "Evaluation of a Ground Penetrating Radar System for Detecting Subsurface Anomalies;" RI 9011, "Corrosion Resistance of Selected Ceramic Materials to Sulfuric Acid;" RI 9021, "Flocculation and Dewatering of Montmorillonite Modified by Ion Exchange;" RI 9035, "Measurement of Dielectric Properties of Minerals at Microwave Frequencies;" RI 9036, "An Infrared Examination of Ion-Exchanged Montmorillonite Treated With Polyethylene Oxide;" RI 9037, "Using Barriers To Reduce Dust Exposure of Longwall Face Workers;" RI 9052, "Steam-Induced Volatilization of Silica From Refractories;" Information Circular (IC) 9076, "Coal Mine Roof Instability: Categories and Causes;" IC 9077, "Dust Control on Longwall Shearers Using Water-Jet-Assisted Cutting;" IC 9080, "Economic Evaluation of Horizontal Borehole Drilling for Methane Drainage From Coalbeds;" and IC 9114, "Dust Controls To Improve Quality of Longwall Intake Air."

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Activities in the industrial minerals sector were mixed as most facilities operated at less than capacity; development and expansion continued, although at a modest level. Industrial minerals accounted for the bulk of the value of Alabama's total nonfuel mineral production.

**Abrasives (Manufactured).**—One company manufactured artificial abrasives at its

facility in Madison County. Abrasive-grade, high-purity fused aluminum oxide and aluminum zirconium oxide were produced by Norton Co. in Huntsville. According to ADO, Norton underwent a \$200,000 expansion during the year.

**Cement.**—Cement accounted for over one-third of the value of nonmetallic minerals produced in Alabama, with both masonry and portland cement being produced. Alabama ranked fifth nationally in the produc-

tion of masonry cement. Output of both types of cement decreased slightly.

Portland cement was produced at six plants in the State, two in Jefferson County, and one each in Marengo, Mobile, St. Clair, and Shelby Counties. Five plants used the dry process, while one, belonging to Allied Products Co., used the wet process; eight kilns were available. Seven plants produced masonry cement; Cheney Limé & Cement Co. was one of two plants nationally that produced masonry cement exclusively. Five of the six operating companies were owned by foreign companies. Principal raw materials used in making cement included cement rock, chalk, clays, gypsum, iron ore, limestone, sand, and shale; coal and natural gas were used as fuel.

Expansions and modernization projects at cement plants were announced through ADO and totaled \$13 million. Improvements were made by Citadel Cement Corp. (\$3.1 million), Lehigh Portland Cement Co. (\$3.7 million), and National Cement Co. Inc. (\$6.2 million).

Ideal Basic Industries Inc., shut down since the end of 1984, ground clinker imported from Greece, Mexico, and Spain. Total clinker imported through the Port of Mobile was 783,000 short tons. Late in the year, Holderbank Financiere Glaris S.A. (Switzerland) purchased 68% of Ideal for a reported \$110 million plus \$83.5 million in notes. This acquisition makes Holderbank the second largest producer of cement in the Nation. With the increased importation of cement and clinker, not one cement kiln on the gulf coast remains in operation. Additionally, increased competition restricted to some extent the market areas of nearly all cement facilities of the State.

**Table 4.—Alabama: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	6	6
Production	3,723,034	3,494,079
Shipments from mills:		
Quantity	3,721,434	3,477,465
Value	\$165,971,931	\$153,629,167
Stocks at mills, Dec. 31	378,386	361,106

**Clays.**—Common clay, fire clay, bentonite, and kaolin were produced in Alabama, with total output and value increasing over

those of 1985. Clays ranked fifth in mineral value in Alabama in 1986 as 24 companies mined clay at 34 pits in 17 counties. Alabama ranked third in the Nation in output of fire clay and sixth in kaolin.

Common clay was mined by 15 companies at 23 pits in 14 counties. Leading counties were Jefferson, Shelby, and Sumter. Output increased along with value; major uses were brick, cement, and concrete block. Boral Ltd. has purchased 100% ownership of Birmingham Clay Products Co. Inc., previously a 50% owned associate; acquisition cost was about \$7.5 million.

Production and value of fire clay decreased from those of 1985. Fire clay was mined by four companies at five pits in Calhoun, St. Clair, and Shelby Counties.

American Colloid Co. mined bentonite at its operation in Lowndes County for use in drilling mud and the foundry industry; output decreased as value increased. ADO reported that Alabama Bentonite Clay Co. opened a \$1.6 million facility at Coffeetville to recycle discarded drilling muds.

Kaolin was mined by four companies at six pits in Barbour and St. Clair Counties. Production decreased from that of 1985, but value increased. Major uses were in firebrick and other refractories. Combustion Engineering Inc., Birmingham, and Harbison-Walker Refractories Co. Inc., Fairfield, modernized their operations during the year; both specialized in refractory castings. Kaolin occurred in association with bauxite, which was also used for refractory purposes. Mining companies continued to operate at relatively reduced levels during the year.

**Fluorspar.**—International Minerals & Chemical Corp. operated a fluosilicic acid plant at Florence. 3M Corp.'s Specialty Chemicals Div. operated a plant at Decatur to manufacture products for the rubber industry. The company produced a fluoroelastomer used in nonmetallic ducting-system expansion joints for pollution control.

**Lime.**—Alabama ranked fifth in the Nation in output of lime, which was the third most valuable commodity produced in Alabama in 1986. Production and value decreased from those of 1985. Output was down due to the prolonged steel industry shutdown. Four companies produced lime in five plants in Shelby County. Output of both hydrated lime and quicklime decreased.

Table 5.—Alabama: Lime sold or used by producers, by use

Use	1985		1986	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp.....	365,478	\$15,512	353,523	\$14,865
Water purification.....	196,405	8,692	193,744	8,395
Sewage treatment.....	74,492	3,159	W	W
Road and soil stabilization.....	21,709	940	25,296	1,107
Other <sup>1</sup> .....	557,958	23,992	607,678	26,010
Total.....	1,216,042	52,295	1,180,241	50,377

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes acid water neutralization, agriculture, alkalies, animal and human food, aluminum and bauxite, basic oxygen steel, finishing lime, magnesia from seawater or brine, mason's lime, metallurgy, other ore concentration, other chemical and industrial uses, petroleum refining, wire drawing (1986), and data indicated by symbol W.

**Mullite (Synthetic).**—Harbison-Walker produced synthetic mullite at its facility at Eufaula; output decreased. The high-temperature sintered product was used primarily for the manufacture of refractories, mainly for the steel industry. Alabama was one of four States with a recorded production of synthetic mullite, a product of sintering a mixture of aluminous and siliceous material.

**Nitrogen.**—Tennessee Valley Authority and U.S.S. Agri-Chemicals Inc. produced anhydrous ammonia at plants at Muscle Shoals and Cherokee, respectively. Annual capacity for the two plants was 249,000 short tons. The Alabama Directory of Mining and Manufacturing also listed Estech Corp., Dothan, and Hercules Inc., Bessemer, as having anhydrous ammonia in their product line.

**Perlite (Expanded).**—W. R. Grace & Co., Birmingham, and National Gypsum Co., Mobile, expanded perlite from ore shipped in from the Western United States. Production and value increased slightly over those of 1985. The expanded perlite was used for formed products, horticultural purposes, and concrete aggregate.

**Salt.**—Olin Corp. produced salt from brine wells by solution mining a near-surface salt dome in Washington County. Alabama ranked eighth nationally in output of salt. Output and value increased slightly over those of 1985. Three basic products were produced—chlorine, sodium hydroxide, and sodium chlorate; a portion of the solid salt was shipped to Olin's plant in Augusta, GA. Cargill Co. planned to situate a salt handling facility at the Port of Florence.

**Sand and Gravel.**—Alabama produced both construction and industrial sand and

gravel in 1985. Output was from 60 companies producing from 71 operations in 26 counties. Total output remained at about the same level as in 1985, but was still below the record-high output in the late 1970's. According to ADO, one new operation, Southern Silica Inc., opened in Elmore. Three others modernized their operations: Southern Ready-Mix Inc., Selma; Dirt Inc., Wilmer; and R & S Materials Inc., Montgomery. During the year, because of drought conditions, the Corps of Engineers reduced the waterflow on the Alabama River system by 25%. Several sand and gravel operations, both dredges and those shipping by barge, were adversely impacted by this action.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the fourth leading commodity in value among the nonfuel minerals produced in Alabama. The slight decrease in 1986 was basically due to a decrease in construction activities, both highway and nonresidential building. Many facilities operated intermittently during the year, depending primarily on local markets, which continued to fluctuate. Most operations were relatively small with no individual pit producing more than 1.5 million short tons. Construction sand and gravel was produced at 64 operations in 26 counties; leading counties were Montgomery, Macon, and Franklin. Major transportation was by truck with lesser amounts shipped by rail and water.

**Table 6.—Alabama: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,119	\$10,158	\$2.47
Plaster and gunitite sands -----	372	1,156	3.11
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	W	W	4.14
Asphaltic concrete aggregates and other bituminous mixtures -----	1,704	6,279	3.68
Road base and coverings -----	847	1,962	2.32
Fill -----	158	199	1.26
Railroad ballast -----	27	71	2.63
Roofing granules -----	79	555	7.03
Other -----	1,040	4,113	3.95
Other unspecified <sup>1</sup> -----	2,435	6,314	2.59
Total or average -----	10,781	30,807	2.86

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Industrial.**—Six companies produced industrial sand and gravel with output decreasing from that of 1985. Industrial sand and gravel was used primarily by foundries. All producers were relatively small, with individual output under 200,000 short tons per year.

**Slag—Iron and Steel.**—Jim Walter Resources Inc., Birmingham, and Vulcan Materials Co., Fairfield and Gadsden, air-cooled blast furnace slag, which is typically used as road base, railroad ballast, and as asphaltic concrete aggregate. Vulcan sold steel slag for similar uses. Total output and value decreased 65% and 61%, respectively. Output of both iron slag and steel slag decreased.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone ranked second in mineral value in Alabama with output estimated to have decreased from that of 1985. Dolomite, granite, limestone, and marble were produced in the State. In 1985, Alabama was second in the Nation in output of crushed marble. Crushed stone was used primarily in cement manufacture, as concrete aggregate, and as a road base.

In 1985, 30 companies produced crushed stone at 45 operations; major producing counties were Shelby, Jefferson, and Madison. The Alabama Department of Industrial Relations estimates that in the fiscal year ending September 30, 1986, nearly 25 million short tons of stone was produced; nine quarries produced in excess of 1 million tons. ADO reported that Hoover Inc. opened

two new quarries in the northern part of the State at Huntsville and Madison. Hoover, along with Vulcan, received environmental complaints because of the proximity of its operations to Huntsville residential areas. ADO also reported expansions at Covington Stone Co.'s Fort Payne quarry and at Dolcito Quarry Co.'s operation at Tarrant. Most crushed stone facilities operated periodically during the year because of sporadic construction activities.

With the completion of the Tennessee-Tombigbee Waterway, marketing of crushed stone along the gulf coast has become more intense. To meet the demands of the area, crushed stone is not only imported from abroad, but also shipped in from Kentucky and other domestic sources.

**Dimension.**—Output of dimension stone decreased over 22% while value decreased nearly 64%. Alabama ranked fifth nationally in output of dimension marble. Marble was quarried in Talladega County; limestone, from an underground operation in Franklin County; and sandstone, in Blount County.

**Sulfur (Recovered).**—Alabama ranked seventh nationally in output of recovered sulfur. Two companies recovered sulfur from natural gas processing plants in Escambia and Washington Counties. Two other companies recovered sulfur from petroleum refineries in Mobile and Tuscaloosa Counties. Exxon Co., Hunt Oil Co., Phillips Petroleum Co., and Union Oil Co. sold 341,000 metric tons valued at \$36.5 million, a decrease in output but an increase in value compared with the 1985 figures. Mobil Oil Corp. completed a sulfur recovery unit at its natural gas plant in Mobile County. The unit was expected to produce 125 tons per day originally, with maximum

output of 230 tons per day expected by early 1987. A sulfur severance tax, supported by the Governor's Office, failed to pass the Alabama Senate during the year; proponents reported the tax would generate \$3 million per year for the State.

**Talc.**—Cyprus Industrial Minerals Co. ground talc from its operations in Montana at its plant near Alpine. The product was used primarily in paper, cosmetics, paint, plastics, rubber, and ceramics. Cyprus announced plans to mine talc near Alpine beginning in 1987. Cyprus has obtained surface and mineral rights on about 3,000 acres of land; drilling in 1986 indicated the presence of substantial quantities of talc.

**Vermiculite (Exfoliated).**—W. R. Grace, Irondale, exfoliated vermiculite from crude ore shipped into the State. Major uses were in concrete aggregate, block insulation, and loose fill insulation, and as a sand conditioner.

## METALS

Primary metal production has been one of the most important industries in the State; however, its impact has decreased over the last decade. Many of the State's economic problems could be traced to the downward trend of the metals industry. The primary metals industry in the State consisted of aluminum, ferroalloys, steel, and various foundries scattered throughout the State.

**Aluminum.**—Two companies, Revere Copper & Brass Inc. in Scottsboro and Reynolds Metals Co. in Sheffield, have facilities for producing aluminum; no production was reported. Reynolds permanently closed its seven-potline, 183,000-metric-ton-per-year aluminum plant in February; the potlines had been down since early 1985. High power costs and low market prices for aluminum were cited as major factors in the closure. Reynolds continued to operate the Southern Reclamation Co., which recovered aluminum from scrap cans, and an alloy plant that produced beverage feedstock for aluminum cans.

U.S. Die Casting and Development Corp. purchased the Ford Motor Co.'s aluminum casting facility in Listerhill. The diecasting company planned to produce parts for the automotive and boat industry. U.S. Reclamation Co. leased a portion of the facility to process aluminum scrap.

Southern Aluminum Casting Co. completed a \$1.5 million expansion at its facility in Bay Minette. The company produces

intake manifolds for automobiles.

**Bauxite.**—Alabama was one of two States producing bauxite. Three companies mined bauxite from pits in Barbour and Henry Counties for use in refractories. Production and value increased significantly over those of 1985.

**Ferroalloys.**—Alabama ranked second nationally in shipments of ferroalloys with output and value increasing nearly 95% and 26%, respectively. Products included ferrosilicon and silicon metal. Although shipments increased, many of the ferroalloy plants operated at reduced levels of output; prices and imports were cited as reasons for the relatively low output. Reynolds completed renovation of its silicon furnace, down from February until October. Two of the three furnaces at Ohio Ferro-Alloys Corp.'s Mount Meigs plant operated during the year. International Minerals sold its ferrosilicon production facilities in Bridgeport to Applied Industrial Mineral Corp.

**Gold.**—Developments in Alabama were restricted to recreational gold mining in eastern Alabama.

**Iron and Steel.**—Alabama produced pig iron, but shipments decreased along with value. Gulf States Steel Corp., Gadsden, and USX Corp., Fairfield, were the only integrated companies in Alabama; both companies operated at less than capacity for the year. Minimills operating in Alabama include Birmingham Steel Corp., which produces bars; Commercial Metals Co., which produces bars and structural products; and SMI Steel Inc.

The Brenlin Group, a holding company from Akron, OH, took over Gulf States' operations on January 31. After minor patching of the blast furnace, the facility returned to making steel in mid-March. The facility had a capacity to make 900,000 short tons per year of steel, but could finish 1.7 million tons of steel. Semifinished slabs were imported from Brazil to more fully utilize the finishing end of the plant. Long-range plans called for a \$107 million capital improvement program, including new electric furnaces, installing a hot coil box in the hot-strip mill, relining the blast furnace, improving coke batteries, and making additions to finishing lines.

USX operated on a reduced schedule during the year. In March, the pipe mill was shut down because of falling oil prices; output of the pipe mill was used in oil drilling. Workers walked off the job at midyear because of a labor dispute and



remained off for the rest of 1986. USX contracted with Tippins Machinery Co. to build a second continuous slab caster at the Fairfield Works. The \$200 million facility will have a capacity of 2 million tons per year. About 400,000 tons per year of slabs will be sold to Tuscaloosa Steel Corp. Construction was scheduled to start in 1987 with completion late in 1988.

Tuscaloosa Steel, Tuscaloosa, operated throughout the year. Although test runs started late in 1985, actual production at the rolling mill started in January. In May, a second shift was added to increase output to 144,000 tons per year; capacity was 750,000 tons per year. Tuscaloosa Steel imported steel slab from British Steel Corp. Because of a voluntary restraint agreement, only 200,000 tons per year was allowed. Plans called for the mill to receive the balance of its needs from the new caster of USX at Fairfield. Until the caster is finished, slabs will be shipped from USX's Gary, IN, works.

SMI Steel's minimill operated at record-high production during the year. A new steel-finishing facility was completed, increasing output to 240,000 tons per year. Other facilities were added, including a new baghouse.

Birmingham Steel acquired minimill operations in Virginia and Washington, bringing the number of plants operated to six. Total output for the company is 1.1 million tons per year.

*Ferrous Foundries.*—Iron and steel found-

ries were an important industry that directly affected mineral producers in the State and region. In addition to scrap, raw material used included clays, limestone, and sand. Attalla Casting Co. began operation at its gray iron casting facility in Attalla; capacity is 8,000 short tons per year. In addition, ADO reported expansions of 14 other facilities during the year; cost of these expansions exceeded \$4 million. The Alabama Directory of Mining and Manufacturing listed 43 gray iron foundries, 24 steel foundries, and 6 steel investment foundries. In addition, there were 6 aluminum smelters and 14 secondary nonferrous smelters.

*Manganese.*—Manganese dioxide and chromite were ground by N. K. Industries Inc. at its facilities in Phenix City for use in brick colorization. The company completed installation of a second ball mill. Sources of raw material were Australia (manganese) and Montana (chromite).

*Rutile (Synthetic).*—Kerr-McGee Corp. operated a 110,000-short-ton-per-year synthetic rutile plant in Mobile; output was shipped to Hamilton, MS, for processing to titanium dioxide pigments. Ilmenite from Australia was used as feed material for the synthetic rutile plant; about 230,000 short tons was imported through the Port of Mobile, an increase over that of 1985.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>State geologist, Geological Survey of Alabama, Tuscaloosa, AL.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum (smelters):</b>			
Revere Copper & Brass Inc. ----	Box 191 Rome, NY 13440	Plant -----	Jackson.
Reynolds Metals Co. -----	Reynolds Metals Bldg. Richmond, VA 23218	----do-----	Colbert.
<b>Bauxite:</b>			
A. P. Green Refractories Co., <sup>1</sup> a subsidiary of USG Corp.	Mexico, MO 65265-----	Mine and plant -	Barbour.
Harbison-Walker Refractories Co. Inc., <sup>2</sup> a division of Dresser Industries Inc.	Dale Rd. Route 1, Box 58 Eufaula, AL 36027	----do-----	Barbour and Henry.
Mullite Co. of America -----	901 East 8th Ave. King of Prussia, PA 19406	Mines -----	Do.
<b>Cement:</b>			
Allied Products Co. <sup>3</sup> -----	Box 36130 Birmingham, AL 35236	Plants-----	Jefferson and Shelby.
Blue Circle Inc. <sup>4</sup> -----	Box 182 Calera, AL 35040	Plant -----	Shelby.
Citadel Cement Corp.-----	2625 Cumberland Parkway, NW. Atlanta, GA 30339	----do-----	Marengo.
Ideal Basic Industries Inc. <sup>4</sup> ----	950 17th St. Box 8789 Denver, CO 80201	Plants-----	Mobile.
Lehigh Portland Cement Co. ---	Box 1882 713 Hamilton Mall Allentown, PA 18105	Plant -----	Jefferson.
National Cement Co. Inc. -----	Box 7348 Mountain Brook Station Birmingham, AL 35223	----do-----	St. Clair.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
Bickerstaff Clay Products Co. Inc	Box 1178 Columbus, AL 31902	Mines -----	Jefferson and Russell.
Blue Circle Inc -----	Box 182 Calera, AL 35040	Mine -----	Shelby.
Jenkins Brick Co -----	Box 91 Montgomery, AL 37101	Mines -----	Chilton, Elmore, Montgomery.
Livlite Corp -----	Drawer V Livingston, AL 35470	Mine -----	Sumter.
<b>Ferroalloys:</b>			
Interlake Inc., Globe Metal- lurgical Div.	Box 348 Selma, AL 36701	Electric furnace	Dallas.
International Minerals & Chem- ical Corp., TAC Alloys Div.	Garner Rd. Bridgeport, AL 35740	----do-----	Jackson.
Ohio Ferro-Alloys Corp -----	Box 68 Montgomery, AL 36057	----do-----	Montgomery.
Reynolds Metals Co -----	Box 191 Sheffield, AL 35660	----do-----	Colbert.
<b>Lime:</b>			
Blue Circle Inc -----	15 South 20th St. Birmingham, AL 35233	Plant -----	Shelby.
Cheney Lime & Cement Co ----	Allgood, AL 35013 -----	----do-----	Do.
S. I. Lime Co -----	Suite 204 Three Riverchase Office Plaza Birmingham, AL 35244	----do-----	Do.
<b>Pig iron:</b>			
Gulf States Steel Corp -----	174 South 26th St. Gadsden, AL 35901	Furnaces and mills.	Etowah and Jeffer- son.
USX Corp -----	Box 599 Fairfield, AL 35064	----do-----	Jefferson.
Jim Walter Resources Inc -----	330 1st Ave., North Birmingham, AL 35202	Furnaces -----	Do.
<b>Salt:</b>			
Olin Corp -----	120 Long Ridge Rd. Stamford, CT 06304	Brine wells ----	Washington.
<b>Sand and gravel:</b>			
Holland and Woodward Co. Inc --	Box 1947 Decatur, AL 35601	Surface mine and plant.	Franklin.
R & S Materials Inc -----	Box 3547 Montgomery, AL 36109	----do-----	Autauga, Elmore, Montgomery.
Southern Industries, Radcliff Materials.	Box 2068 Mobile, AL 36601	----do-----	Mobile and Mont- gomery.
C. T. Thackston Sand & Gravel Inc.	Box 3211 Montgomery, AL 36109	----do-----	Montgomery.
<b>Stone:</b>			
Allied Products Co -----	Box 628 Alabaster, AL 35007	Quarries -----	Jefferson and Shelby.
Dolcito Quarry Co -----	Box 6566 Birmingham, AL 35217	Quarry -----	Jefferson.
Ideal Basic Industries Inc -----	950 17th St. Box 3739 Denver, CO 80201	----do-----	Monroe.
Southern Stone Co. Inc. <sup>5</sup> -----	Box C-200 Birmingham, AL 35283	Quarries -----	Jefferson, Lee, Shelby.
Vulcan Materials Co. <sup>6</sup> -----	Box 7324-A Birmingham, AL 35253	----do-----	Calhoun, Colbert, Etowah, Frank- lin, Jackson, Jefferson, Madison, Morgan, Shelby.
<b>Talc:</b>			
Cyprus Industrial Minerals Co --	Alpine, AL 35014 -----	Plant -----	Talladega.

<sup>1</sup>Also kaolin.<sup>2</sup>Also kaolin and synthetic mullite.<sup>3</sup>Also lime.<sup>4</sup>Also clays and stone.<sup>5</sup>Also sand and gravel.<sup>6</sup>Also clays and sand and gravel.



# The Mineral Industry of Alaska

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

By Tom L. Pittman<sup>1</sup>

The value of nonfuel mineral production reported in Alaska in 1986 was \$91.5 million; in 1985, the value was \$90 million. The slight increase was due mainly to the increased production of gold. Alaska ranked 42d in the value of nonfuel mineral production, the same as in 1984 and 1985, and 43d in the value of industrial minerals production. Construction sand and gravel production declined because of reduced construction in the larger urban areas and the large reductions in oilfield development and infrastructure construction projects on the

North Slope. The number of mechanized placer gold mines decreased more than 25%, mainly those of smaller scale operators.

Two lawsuits contesting management practices and oversight of mining operations on Federal lands managed by the National Park Service (NPS) and the U.S. Bureau of Land Management (BLM) resulted in injunctions that shut down most of these placers. Alleged violations of water quality regulations and uncertainties about State standards closed some operations.

Table 1.—Nonfuel mineral production in Alaska<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones.....	NA	<sup>e</sup> \$60	NA	<sup>e</sup> \$60	NA	\$25
Gold (recoverable content of ores, etc.) troy ounces...	19,433	7,009	44,733	14,210	48,271	17,775
Sand and gravel (construction) thousand short tons...	30,861	66,883	<sup>e</sup> 29,000	<sup>e</sup> 63,000	27,762	61,954
Silver (recoverable content of ores, etc.) thousand troy ounces...	( <sup>d</sup> )	1	W	W	W	W
Stone (crushed) --- thousand short tons...	<sup>e</sup> 2,500	<sup>e</sup> 10,800	1,907	8,535	<sup>e</sup> 2,000	<sup>e</sup> 8,500
Combined value of cement (portland), tin, and values indicated by symbol W .....	XX	<sup>f</sup> 2,543	XX	4,164	XX	3,226
Total .....	XX	87,296	XX	89,969	XX	91,480

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Less than 1/2 unit.

**Table 2.—Nonfuel minerals produced in Alaska in 1985, by region<sup>1</sup>**

Region	Minerals produced in order of value
Alaska Peninsula ----	Stone (crushed).
Cook Inlet-Susitna ----	Gold, cement (portland), stone (crushed), silver.
Kenai Peninsula ----	Gold.
Seward Peninsula ----	Gold, tin, silver.
Southeastern Alaska --	Stone (crushed).
Yukon River ----	Gold, stone (crushed), silver.
Undistributed <sup>2</sup> ----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for regions not listed.

<sup>2</sup>Data not available by region for minerals listed.

**Table 3.—Indicators of Alaska business activity**

	1984 <sup>†</sup>	1985	1986 <sup>‡</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	505	522	594
Total civilian labor force -----	do	247	250	256
Unemployment -----	percent	10.0	9.7	10.8
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup> -----	thousands	8.7	9.5	9.0
Manufacturing total -----	do	11.3	12.1	12.4
Stone, clay, and glass products <sup>1</sup> -----	do	.3	.3	.3
Petroleum and coal products <sup>1</sup> -----	do	.2	.2	.2
Construction -----	do	20.4	18.6	13.2
Transportation and public utilities -----	do	19.2	18.7	18.2
Wholesale and retail trade -----	do	44.5	45.8	44.3
Finance, insurance, real estate -----	do	12.2	12.8	12.6
Services -----	do	43.0	44.8	44.2
Government and government enterprises -----	do	66.5	68.3	68.2
Total <sup>2</sup> -----	do	225.7	230.7	222.1
<b>Personal income:</b>				
Total -----	millions	\$9,150	\$9,636	\$9,495
Per capita -----	do	\$18,109	\$18,444	\$17,796
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	39.3	40.7	41.1
Mining -----	do	50.4	51.2	52.0
Total average hourly earnings, production workers -----	do	\$12.3	\$12.2	\$11.6
Mining -----	do	\$23.3	\$23.9	\$23.0
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$9	-\$2	-\$2
Nonfarm -----	do	\$8,453	\$8,675	\$8,360
Mining total -----	do	\$563	\$646	\$659
Metal mining -----	do	\$21	\$21	\$22
Oil and gas extraction -----	do	\$527	\$607	\$630
Manufacturing total -----	do	\$344	\$349	\$364
Primary metal industries -----	do	\$3	\$1	\$1
Stone, clay, and glass products -----	do	\$21	\$19	\$16
Petroleum and coal products -----	do	\$14	\$16	\$19
Construction -----	do	\$1,391	\$1,191	\$950
Transportation and public utilities -----	do	\$827	\$795	\$746
Wholesale and retail trade -----	do	\$1,072	\$1,089	\$1,008
Finance, insurance, real estate -----	do	\$352	\$380	\$384
Services -----	do	\$1,408	\$1,443	\$1,389
Government and government enterprises -----	do	\$2,454	\$2,614	\$2,685
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do	6,486	4,029	1,353
Value of nonresidential construction <sup>4</sup> -----	millions	\$405.6	\$299.0	\$142.9
Value of State road contract awards <sup>5</sup> -----	do	\$156.0	\$159.0	\$131.9
Shipments of portland cement to and within the State -----	thousand short tons	197	156	121
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$87.3	\$90.0	\$91.5
Value per capita -----	do	\$173	\$172	\$171

<sup>†</sup>Preliminary. <sup>‡</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

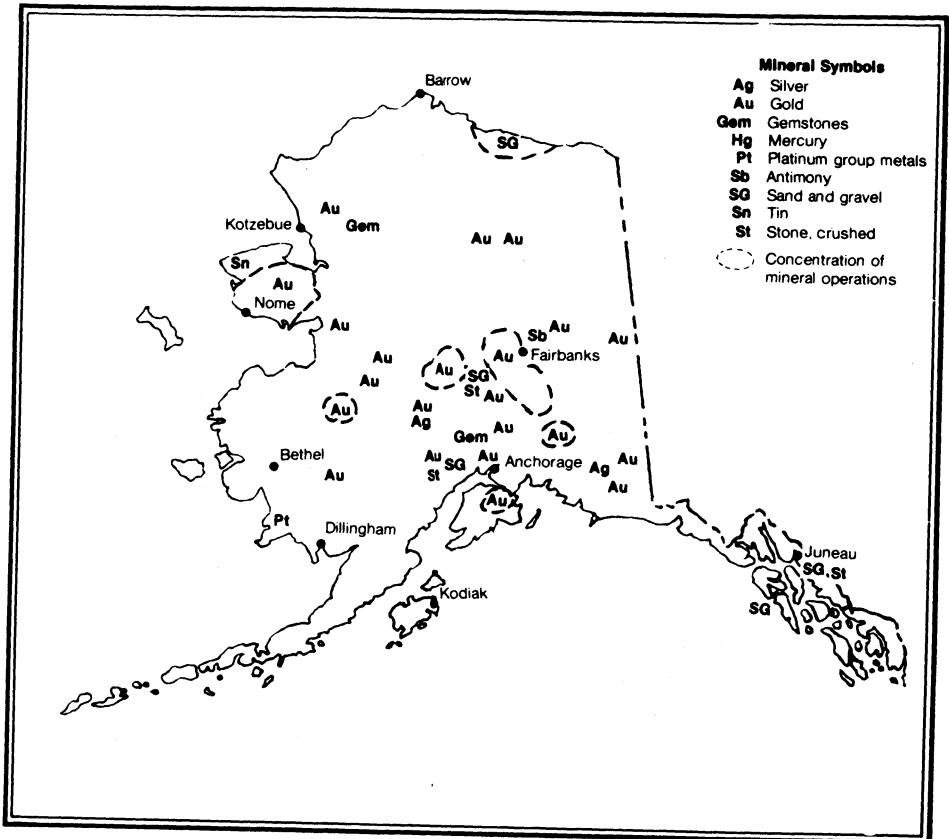


Figure 1.—Principal mineral-producing localities in Alaska.

**Trends and Developments.**—There were 5,315 new mining claims recorded, compared with 6,773 recorded in 1985, showing a significant drop in field exploration effort. Exploration expenditures on promising claims were usually greater than on new prospects and locations. Most of the new claims recorded were located for precious metals, and relatively few precious metals claims were abandoned. Several companies continued to search for platinum-group metals.

Development outlays were about two-thirds of the amounts expended in 1985. Several projects active in 1986 are scheduled to continue at expanded scales in 1987 and should substantially increase mine development in the State. A barge landing and staging area was built at the port site on the Chukchi Sea preparatory to complet-

ing the 52-mile access road to the Red Dog zinc mine in 1987. Greens Creek Mining Co. continued exploration and development at its silver-gold-lead-zinc deposit near Juneau, built an access road from the port site to the mine, and announced it will begin driving a 6,000-foot haulage adit early in 1987.

Lode gold mines were again becoming attractive development targets. The Ryan Lode Mine, west of Fairbanks, has been under development as an open pit gold mine using heap leaching for metal recovery; the mine will operate on a production basis in 1987. Because of the apparent success of this far-north operation, several companies were investigating the applicability of heap-leach cyanidation to other low-grade Alaskan gold deposits.

The number of smaller mechanized plac-

er gold mines continued to decline, but larger operators tended to increase operating rates and unit efficiencies and to stress practical economies. Offshore gold and platinum placer deposits received increased interest. A very large bucketline dredge was brought to the gold placers in Norton Sound, south of Nome, and operated on an exploration and development basis from August through September 1986. This dredge, the "Bima," will operate on a production scale during the 1987 season.

Underground drift mining for placer gold has been getting increasing consideration for suitable deposits situated in permafrost areas. Drift mining may be used to extract relatively rich, thin gravel deposits overlain by subeconomic overburden, utilizing small-scale conventional methods. A medium-size mechanized drift mine was developed on a deeply buried bench placer near Livengood in 1986. The pay gravel was drilled and blasted, loaded by trackless "scooptram" into a highway-type truck, and hauled to a surface stockpile for later sluicing.

Water quality improved in many of the streams in placer mining areas because of improved construction and operation of settling ponds and owing to enforcement actions by State and Federal agencies. Some of the results of research and experimental work by industry, government agencies, and universities have begun to benefit the placer industry. Results include improved equipment and practices for fine gold recovery; better construction and operation of settling ponds; selection, development, and use of flocculants for improving the quality of recirculated process water and mine-area discharge water; and reclamation and revegetation of mined lands. Some of the projects of the Placer Mining Demonstration Grant Program funded by the State, the site-specific pilot-scale flocculant demonstrations by the U.S. Bureau of Mines, and various efforts of manufacturers and suppliers have benefited the industry.

**Employment.**—State surveys estimated nonfuel mineral industry production employment at about 2,765 persons, down from about 3,665 in 1985. Gold placer mining employed about 1,385 persons, construction sand and gravel about 1,100, crushed and broken stone about 225, and antimony, jade, mercury, soapstone, and tin about 55. These figures do not include employment in mineral exploration and development.

**Exploration Activities.**—The State estimated that exploration expenditures were about \$8.9 million, compared with \$9.2 mil-

lion in 1985. The surveys indicated about 21,800 person days were worked in mineral exploration. Development expenditures decreased to about \$24 million in 1986 from \$34 million in 1985. Owing to the nature of the surveys, it is possible that some of the expenditures listed as development might more properly be classed as exploration.

About 32,400 feet of placer exploration holes and 227,000 feet of thaw-field holes were drilled in 1986, according to State surveys. Over one-half of this exploration drilling was at the Valdez Creek Mining Co. Inc. mine east of Cantwell. The thaw-field work was near Nome, where Alaska Gold Co. was preparing ground ahead of its upland gold dredges. Drilling on hard-rock deposits totaled 50,200 feet, down from 131,700 feet (revised) in 1985. Only 8 companies had major hard-rock drilling programs in 1986, down from 14 companies in 1985. Echo Bay Mines Ltd., at the Alaska Juneau Mine, was believed to be the only new company to begin an exploration drilling program in Alaska in 1986.

**Legislation and Government Programs.**—The first unit of the DeLong Mountains Transportation System was financed by Alaska Industrial Development Authority (AIDA) State revenue bonds. This unit entailed the construction of a large gravel pad, sheet-pile barge dock, and shore facilities that will be used as a staging area for constructing a port and the road to the Red Dog Mine. Enserch Alaska Construction Inc. started the job in the summer of 1986 on a contract valued at \$1.6 million. Early in 1987, AIDA will award a contract for constructing the 52-mile access road from the port site to the Red Dog Mine. This contract was to be completed in 1987.

The projects funded by the State under the \$2.7 million Placer Mining Demonstration Grant Program were completed. The grants were made to qualifying placer operators to demonstrate specified innovative techniques to reduce the use of water, enhance recovery of fine gold, help with tailings disposal, or improve the quality of placer effluents.

The 2d session of the 14th State Legislature passed five bills of interest to the mineral industries. These acts became chapters of State law when the Governor signed them. Chapter 66 established the 52,000-acre Hatcher Pass Public Use Area, containing most of the historic Hatcher Pass mining area, to protect and enhance fishing, wildlife, public recreational uses, and "valid mining claims"; the State may not

acquire private inholdings by eminent domain or dispose of land within the area defined in the chapter.

Chapter 98 established an 11-member Alaska Minerals Commission to identify constraints on the development of minerals and hydrocarbons and to recommend mitigation measures to the 15th and 16th Legislatures. The Commission completed its 1st report and was to present it to the Governor and the 15th Legislature in January 1987. Chapter 135 amended the Alaska Water Use Act (AS46.15), establishing procedures for administration and adjudication of water rights. The other two chapters provided for the disposal of small amounts of materials from State lands.

Geologic mapping and mineral deposit examinations continued in the Haines and Skagway areas by crews from the U.S.

Bureau of Mines and the Division of Geological and Geophysical Surveys (DGGS) of the Alaska Department of Natural Resources. Several reports resulting from this work were released in 1986. The Bureau continued studies in the Juneau mining district and the "Gold Belt." Other studies were made on strategic and critical minerals, and several reports were released. These reports included information on a niobium-bearing deposit near Manley Hot Springs and on possible platinum-metal-group resources north of Paxon and near Goodnews Bay.

The U.S. Geological Survey published a bibliography summarizing data releases and folio reports resulting from its Alaska Mineral Resource Program covering geological and mineral-related research in the State.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Asbestos.**—Doyon Ltd. stopped exploration on its Slate Creek, Champion, and other asbestos deposits early in 1986 after the U.S. Environmental Protection Agency (EPA) announced it intended to ban asbestos entirely and remove all products containing it from the market within the next 10 years. The deposits are about 40 miles southwest of Eagle. Exploration has identified drilled reserves of 55 million short tons of material averaging 6.35% chrysotile fiber at Slate Creek and several million tons of similar material at two other partially explored deposits. Asbestos fiber quality at these deposits ranged from 4A through 7D, Quebec Standard Specifications. Fibers are short to medium in length and possess superior strength.

**Cement.**—Anchorage Sand and Gravel Co. manufactured about 25% more portland cement than in 1985, using domestic clinker and gypsum shipped to Anchorage. The company also operated ready-mixed concrete facilities and a modern concrete block plant.

**Gem Stones.**—The reported value of gem stones produced was about \$25,000, less than one-half of the value reported in 1985. Jade was recovered from lands of the NANA Regional Corp. and from privately owned mining claims near Shungnak, east of Kotzebue. Most of the jade from native lands was taken to NANA's subsidiary, Jade Mountain Products Inc., to be cut and

polished for the production of tile, table tops, and slabs for additional processing or sale. Privately owned jade was generally sold for processing into jewelry or decorative items. Soapstone was recovered from deposits in the Talkeetna and Salcha River areas and carving-grade material was sold to commercial outlets, hobby shops, and individuals. Museum- and collector-grade epidote and some other specimen crystals were marketed by the owners of patented mining claims on Green Monster Mountain, Prince of Wales Island.

A third diamond was found on Crooked Creek, downstream from the sites of the 1982 and 1984 discoveries. Personnel of the Alaska DGGS and the U.S. Bureau of Mines ran grease table, jig, and sluicing concentration tests on Crooked Creek gravels but did not find minerals that might indicate a kimberlite gravel source. Recent discovery of a carbonatite pluton near Tofty may indicate the presence of kimberlite-type rocks in parts of the Porcupine River region and the Yukon-Tanana uplift schist terrain.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production was 27.8 million short tons valued at \$62 million. Production in 1985 was 29 million



tons valued at \$63 million. There was no reported production of industrial sand and gravel in Alaska. Declines in urban building construction and major State-funded projects resulted in a drop in sand and gravel production in city areas. North Slope petroleum development and infrastructure construction decreased because of the drop in oil prices. Most of the sand and gravel used was for maintenance work, including road and ramp repairs and water reservoir improvements, and some preproduction road and crossing construction.

Seward Peninsula road systems from Nome to Council and Nome to Kougarok were repaired by the Alaska Department of Transportation and Public Facilities (DOTPF) and required about 340,000 tons of construction sand and gravel. A considerable portion of the aggregate used on the Seward Peninsula was prepared from tailings of current and old placer mines. In the Eastern Interior region, about 7.1 million tons of sand and gravel was quarried, according to State reports. About 70% of this material was used to complete several DOTPF projects along the Alaska Highway between Dot Lake and the United States-Canada border.

About 5.4 million tons of construction sand and gravel was used in the South-central region, compared with nearly 8 million tons in 1985. This decrease was due mostly to the sharp drop in private and corporate building construction and new public works projects in the Anchorage area. About 40% of the production was hauled from pits in the Palmer-Wasilla area. The Alaska Railroad Corp. operated four 80-car trains daily from these pits during the construction season. City zoning restrictions and exhaustion of important

reserves have necessitated moving away from Anchorage for adequate supplies. Several formerly active companies have quit mining sand and gravel. Native regional corporations were beginning to realize the value of some of their lands for marketable sand and gravel resources.

About 510,000 tons of construction sand and gravel was produced in the Southeastern region. The largest reporting producers were Juneau Ready-Mix Inc. and Gastineau Sand and Gravel Inc., at Juneau. Ketchikan Ready-Mix and Quarry Inc. was the most important producer in the Ketchikan area. Island Construction Inc. had a pit in the Craig and Klawok area on Prince of Wales Island.

The State conducted a telephone survey of over 50 companies that mine construction sand and gravel in Alaska and reported a production of 20,873,110 tons in 1986. The U.S. Bureau of Mines canvass received replies from the BLM and from 19 companies, reporting 21 operators with 134 pits, and producing 27,762,094 tons. Canvass replies do not yield a good indication of end uses because about 93% of the tonnage was listed as unspecified; 3.4% was fill, 1.4% was road base and coverings, 1.2% was concrete aggregates, and the balance was distributed as plaster and gunite sands, asphaltic concrete aggregates, snow and ice control, and other. The largest pits serve North Slope oilfield developments, the most populous areas, and some of the major public works projects. In permafrost areas, gravel sources are usually placer mine tailings or river valley deposits that have been partly or wholly thawed. Listed unit values of sand and gravel ranged from \$1 to over \$45 per ton.

Table 4.—Alaska: Construction sand and gravel sold or used by producers in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	319	\$2,242	\$7.03
Plaster and gunite sands -----	W	W	9.00
Asphaltic concrete aggregates and other bituminous mixtures -----	180	926	5.14
Road base and coverings <sup>1</sup> -----	396	2,040	5.13
Fill -----	948	3,264	3.44
Snow and ice control -----	66	525	7.95
Other -----	19	162	8.52
Other unspecified <sup>2</sup> -----	25,834	52,794	2.04
Total or average -----	27,762	<sup>3</sup> 61,954	2.23

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

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Crushed stone production reported to the U.S. Bureau of Mines in 1986 was 2 million short tons valued at \$8.5 million. The 1985 canvass listed production in that year at 1.9 million tons valued at \$8.5 million. No production of dimension stone was reported in 1986. In the Northern region, an unknown amount of riprap was used in construction of the barge dock on the Chukchi Sea for the DeLong Mountains Transportation System and the Red Dog Mine. In the Western region, the Nome Seawall Project was completed by Kiewit-Pacific Co. The 2-year project required almost 700,000 tons of shot rock and riprap and cost \$22 million. It was funded by the Federal and State Governments. This rock quarry also furnished some of the heavy seawall riprap for the harbor projects on the Pribilof Islands. Yutan Construction Co. mined about 375,000 tons of basalt from its Browns Hill Quarry near Fairbanks. The basalt was used for road ballast, ornamental stone, crushed fill for leach fields, and riprap for flood control along the banks of the Tanana and Chena Rivers. In the Southwestern region, some stone was used in maintenance work and riprap. The Calista Corp. developed its high-quality basalt quarry at Goodnews Bay and was looking for markets for its possible products. The stone is suitable for seawall riprap and armor rock. The site was owned by the Kuitsara Village Corp.

The St. Paul Island harbor and seawall was badly damaged by a severe storm in 1984, and a harbor and boat basin were an economic necessity on St. George Island. Contracts for construction of the containment facilities for these harbors were awarded to Brice Inc. and to S & S Construction Co. The design firm and its consultants determined that rocks weighing from 1.7 to 10 tons each would be required for seawall facing and riprap. The St. George job has used about 320,000 tons of basalt from an adjacent quarry. The quarry became an 8-acre boat basin. No reports were received on the amounts of stone used in the Southeastern region. Significant amounts of shot rock were used as fill and surfacing materials in the construction of logging roads, an access road at the Alaska Juneau Mine, about 7 miles of road at the Greens Creek Mine

project, and various maintenance and other jobs in Southeastern Alaska.

## METALS

**Antimony.**—The State reported antimony production was 45,000 pounds, valued at \$65,000. In 1985, reported production was 65,000 pounds valued at \$98,000. Antimony ore and concentrates were shipped by Rudy Vetter and Associates as byproducts from a gold lode mine north of Fairbanks. The market price of antimony has been too low the last 2 years to encourage miners to work and sort most of the known small, high-grade stibnite vein deposits.

**Copper and Lead.**—No production of copper or lead ores was reported in 1986. Copper and lead prospects and deposits that are not known to contain significant amounts of precious metals have not attracted much interest from exploration companies. In many instances, they have been held by a minimum of expenditures for payments or assessment work, sold, or abandoned. Kennecott sold its Ruby Creek copper-zinc deposit in the Brooks Range to NANA. It kept and was maintaining the Arctic Camp deposit, also in the Ambler District. Indicated reserves at Arctic Camp are about 40 million short tons averaging 4% copper, 5.5% zinc, 1.6 troy ounces of silver per ton, and 0.02 troy ounce of gold per ton. Ambler Mining Co., a subsidiary of Sunshine Mining Co., sold many of its remaining claim groups to NANA and ceased work on most of the rest. Nerco Minerals Co./Resource Associates of Alaska conducted a modest assessment work and drilling program on the Zackley copper-gold-silver skarn deposits west of Paxon. Indicated reserves were reported to be 1.25 million tons averaging 0.17 ounce of gold per ton with additional values in copper and silver.

Long Lac Minerals Ltd. continued exploratory work on its claim groups in the Southeastern region. Galactic Resources Ltd. maintained its copper-nickel-cobalt properties at Bohemia Basin, on Yakobi Island, and at Mirror Harbor on the west coast of Chichagof Island.

The Kennecott copper mines have been placed in the National Roster of Historic Places by the U.S. Department of the Interior. The landmark site includes the mill town, 45 major buildings, a tramway system, and the Bonanza, Erie, Glacier, and Jumbo Mines and camps. The mines are north of McCarthy in the Wrangell Moun-

**tains.**

**Gold.**—Gold production reported to the U.S. Bureau of Mines in 1986 was 48,271 troy ounces valued at \$17.8 million. This production, reported by 15 companies operating 16 washing plants, is believed to be about 30% of the actual 1986 production. The State estimated about 160,000 ounces, valued at \$60.8 million, an estimate based on completed questionnaires from 115 mechanized operations (up from 78 in 1985) that gave production number estimates, company news releases and annual reports to stockholders, information from Alaska DGGs employees working in 3 of the 7 regions of the State, estimates from precious metals refiners, and information from 2 informal surveys conducted by the mining community.

A similar State survey estimated 1985 gold production at 190,000 ounces valued at \$61.2 million. The State survey estimated that 195 mechanized mines operated in 1986, down from 266 in 1985. A total of 1,155 miners were employed in mechanized mines during the 1986 season, compared with 1,540 employed in 1985. Recreational miners and claim owners doing assessment work reported 80 operations employing 230 people, down from 95 operations employing 275 in 1985.

The State estimated that 4 mechanized placers in the Northern region produced 4,500 ounces of gold in 1986, down from 14,400 ounces from 18 operators in 1985.

The Western region produced 53,000 ounces of gold from 42 placer operations according to the State survey, an increase of over 30% above that of 1985. Most of the increase came from the Seward Peninsula.

The Ruby-Poorman District in the Yukon River Basin and the Tolstoi District in the Innoko drainage also were productive. Alaska Gold operated Dredge No. 6 near Nome for 155 days between May and October and processed about 800,000 cubic yards of gravel. A thaw-field drilling program was completed and the company also planned to run Dredge No. 5 in 1987. Windfall Gold Mining Corp., operating in the Copper Gulch open cut mine near Nome, processed almost 700,000 cubic yards during its 160-day season. Inspiration Gold Inc., formerly Inspiration Mines Inc., purchased the 33-cubic-foot offshore Indonesian tin mining dredge, the Bima, and had it modified for gold recovery in Singapore and barged to Nome. It is believed to be the largest bucketline dredge built, with displacement of nearly 15,000 short tons. The Bima ran production and

shakedown tests offshore from Nome between August 5 and October 1. It was then barged to Tacoma, WA, for weatherization, modification of the gold recovery system, and other work. The dredge was scheduled to arrive at Nome about June 1, 1987, and operate on a production basis. During the 1986 test runs, it recovered about 3,000 ounces of gold and operated with a crew of about 84 people.

The Eastern Interior region produced an estimated 43,350 ounces of gold from 83 mines, down from 66,000 ounces from 135 mines in 1985, by State estimates. Employment dropped from 740 people in 1985 to 375. Most of the declines resulted from the effects of water quality regulations, environmental lawsuits, and exhaustion of economic placer reserves. Only 21 placer mines produced gold in the Circle District, about one-half of the number active in 1985. Activity in the Fortymile District, with 12 mines, was about the same as in 1985. There was reduced activity this year in the Liven-good area.

Eight companies were placer gold operators in the Fairbanks District, about the same as in 1985. Six operations were worked in the Bonfield District. There was one each on California, St. George, and Tatlanika Creeks and the Totatlanika River, and two on Moose Creek. No gold or silver was produced from the Kantishna District for the first time since its discovery in 1905 because of the decision in the Sierra-Club-versus-NPS lawsuit.

La Teko Resources Ltd. and a subsidiary, Citygold Inc., continued heap-leaching cyanidation pilot tests at the Ryan Lode Mine west of Fairbanks. Results summarized from a State report and contact with a company official indicate the company has recovered over 70% of the gold on a pilot lot with a heads value of 0.115 ounce of gold per ton. La Teko plans on a 5-month leaching season and on mining throughout the year. In October, 750 lineal feet of the shear zone deposit had been stripped and sampled and 70,200 tons of ore grading 0.21 ounce of gold per ton was prepared for production. Previous exploration indicated the ore zone is almost 4,000 feet long and is from 20 to 130 feet wide. Drill-indicated reserves to the 500-foot level are 1.9 million tons averaging 0.13 ounce of gold per ton.

About a dozen placer operators conducted exploration projects in the Circle District, five in the Fairbanks District, and others in the Bonfield, Fortymile, and Tofty Districts.

State surveys show the Southwestern region produced about 18,000 ounces of gold from 33 placer mines.

About 30,000 ounces of gold was produced by 30 placer mines in the South-central region, a drop of about 26% in volume and 21% in operators, according to State surveys. Valdez Creek Mining operated the most productive placer mine in Alaska. Production reported by Valdez Creek Mining to the State was 28,500 ounces of gold from 143,000 cubic yards of pay gravel. Overburden on the pay gravels ranged from 80 to 300 feet thick. Water seepage caused extensive caving of the pit walls and raised the stripping ratio from the previous range of 5:1 to 8:1 up to 22:1. Installing horizontal drain holes with piping and benching the pit walls finally alleviated the problem. Employment ranged from 85 to 130 people. Valdez Creek Mining was controlled by Camindex Mines Inc., with a 51% interest, Sullivan Mines Ltd. with 26%, and American Barrick Resources Co. with 23%. They were all Canadian operating companies.

Small amounts of gold were recovered in the Porcupine District northwest of Haines by Big Nugget Mining and Dick Peterson on lower and upper Porcupine Creek.

Settlement of the Sierra-Club-versus-NPS lawsuit in 1985 required the NPS to cancel all of the "temporary approvals" to mine in the national parks and preserves in Alaska, and several strict stipulations were mandated relative to issuance of new permits by the NPS. NPS must also prepare environmental impact statements on the cumulative effects of mining in the Wrangell-St. Elias and Denali National Parks and preserves and for the Yukon-Charley Rivers National Preserve. The court allowed NPS to approve plans of operation on a case-by-case basis; of the 20 plans submitted, 3 were

approved, and only 1 operation was mined in 1986. In 1985, 30 mines produced 22,000 ounces of gold from the Kantishna and Nizina areas, under NPS permits.

In the Sierra-Club-versus-Penfold lawsuit, three environmental groups and several Native organizations contended BLM did not properly follow provisions of the 1976 Federal Land Policy and Management Act in protecting the surface environment of mining claims on Federal land. An interim agreement between the litigants forestalled shutting down most Alaskan placer mines, about 80% of which are on Federal land. BLM must prepare environmental assessments of all mining plans before authorizing mine production, make on-site inspections, and collect water samples. It must also evaluate fishing and subsistence hunting effects before approving mining plans. Miners are required to reclaim ground they have disturbed since 1980.

The Trustees of Alaska believe section 6(i) of the Statehood Act required all Federal lands selected by the State be made available for mining only under revenue-producing lease agreements. The group was suing to force the State to replace the current mining claim location provisions with a leasing system. Enforcement of water quality standards based on the 1972 Federal Clean Water Act and some stricter State standards posed serious problems for the placer industry. The State reported through 1986 that 20 gold operators had been charged with water quality violations and faced fines of up to \$10,000 per day if convicted. EPA ordered 24 other operators to obey water pollution laws and threatened enforcement actions. EPA also threatened to cancel 96 mining permits and issued warnings to 405 mining companies.

Table 5.—Alaska: Reported placer production of gold

Year	Mines producing	Material <sup>1</sup> treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value (thousands)	Average value per cubic yard
1982	20	3,264	30,181	\$11,345	\$3.476
1983	20	3,194	39,470	16,735	5.240
1984	14	2,013	19,433	7,009	3.482
1985 <sup>2</sup>	16	1,781	44,733	14,210	7.979
1986	15	1,842	48,271	17,775	9.649

<sup>1</sup>Excludes material treated primarily for the recovery of platinum and lode mine material milled.

<sup>2</sup>Includes small amount of lode mine production to avoid disclosing company proprietary data.

**Mercury.**—No mercury production was reported to the U.S. Bureau of Mines in 1986. According to the State survey, James R. Wylie, owner and operator, reported producing 912 pounds of mercury valued at \$2,800, from the Mountain Top Mine southwest of Sleetmute. The metal was retorted at the property from development ore.

**Molybdenum.**—The selling price and market demand necessary to trigger developing and equipping the Quartz Hill molybdenum deposit for production appeared to be several years in the future. The Revised Draft Environmental Impact Statement will not be reissued until early in 1987 to allow more time for studying and evaluating field and research data. These studies may provide a basis for an agreement by the U.S. Forest Service, EPA, and the U.S. Corps of Engineers on a preferred marine disposal site for the mill tailings. Initial study data indicated there might not be enough volume available in Wilson Arm of Smeaton Bay to provide disposal during the proposed life of the mine. Additional bathymetric surveys show more volume than originally calculated. Settling and compaction tests run on pilot mill tailings from a 5,000-short-ton bulk sample determined that tailings will require less volume than preliminary bench-scale tests indicated.

EPA prefers Boca de Quadra Fiord for Quartz Hill molybdenum tailings disposal because it has enough excess storage volume so tailings could be introduced at a depth greater than the planned depth of 150 feet below sea level.

Factors in favor of disposal into Wilson Arm include limiting major impacts of the mine development to the single drainage containing the bulk of the deposit, the mining and milling plant and infrastructure sites, all access roads, and marine terminal site; no identified significant differences in potential negative impacts relative to the alternate tailings sites; elimination of at least \$59 million in capital costs for tailings tunnel and installations and \$1.6 million per year for pumping and other operating costs; and keeping physical developments out of the Granite Fiords Wilderness Area. The Quartz Hill deposit contains about 10% of the identified molybdenum reserves of the free world. Its drilled reserve is 1.5 billion short tons averaging 0.136% molybdenite.

**Platinum-Group Metals.**—No production of platinum-group metals was reported to the U.S. Bureau of Mines in 1986. The State survey indicated some production, believed

to be small, as a byproduct of placer mining for gold. Amount and value are withheld. Prospecting and exploration activity for these platinum-group metals increased over the interest evinced in 1985. Hanson Properties Inc. operated its Goodnews Bay dredge for 2 weeks, mining and testing recovery in the clay-rich tailings on the Eastern Bench. Orbex Minerals Ltd. and another Canadian company completed an exploration drilling project at the Salt Chuck Mine, a former copper-gold-palladium-platinum producer on Prince of Wales Island.

**Silver.**—The quantity and value of silver produced in Alaska in 1986 reported to the U.S. Bureau of Mines was withheld from publication to protect confidentiality of company data. Silver production reported to the State survey was about 24,000 troy ounces valued at \$134,400. Almost all of the silver produced was alloyed with placer gold. No shipments of silver ores were reported. In 1985, the State estimated silver production at about 28,500 ounces valued at \$171,000. Exploration drilling continued at the Greens Creek Mine, southwest of Juneau. The 39.5% interest in the Greens Creek Mining of Anaconda Minerals Co. was offered for sale in 1985 and purchased by Amselco Minerals Inc., a subsidiary of BP North America Inc. In mid-1986, Amselco purchased the 39.5% interest owned by Noranda Mining Inc. The other interests in Greens Creek Mining were held by CSX Oil and Gas Corp. (12.3%) and Exalas Resources (8.7%).

**Tin.**—In 1986, Lost River Mining produced about 340,000 pounds of tin in high-grade cassiterite concentrates valued at \$890,000, according to a report published by the State survey. The State estimated Alaskan tin production in 1985 at 300,000 pounds valued at \$650,000. Lost River Mining's placer mine is on Cape Creek near Tin City, on the western end of the Seward Peninsula. The placer concentrates were smelted and refined in Singapore. The metal was sold on a consignment basis by a company based in Chicago, IL. Little interest was shown in exploring or exploiting tin deposits lately because of the low prices and chaotic condition of the market.

**Zinc.**—No zinc production was reported in Alaska in 1986. Development of the Red Dog zinc-lead-silver mine was progressing on schedule by Cominco Alaska Inc., the operator, and NANA, the property owner. The State of Alaska, Cominco, and NANA concluded the agreement for financing the

port facility and the 52-mile road to the mine. The agreement was backed up by a letter of credit from several international banks guaranteeing repayment of State revenue bonds financing the road and port. A contract for construction of a shallow-water barge dock and gravel pad to serve as a staging area for road construction was let to Enserch; the project was completed in September. Ralph M. Parsons Co. was awarded a contract for mine planning, design, and construction. On November 26, 1986, Cominco's board of directors approved full development of the mine project with production scheduled for 1991. The ownership of Cominco changed dramatically in Sep-

tember. Canadian Pacific Enterprises Ltd. sold its 52.5% interest. A holding company purchased part of this equity, obtaining a 31% interest in Cominco. Participants in the holding company are Teck Corp., Canadian, with 50%; Metallgesellschaft AG, West German, 25%; and MIM Holdings Ltd., Australian, 25%.

Patino Inc. continued exploration at the high-grade, partly oxidized Step Mountain zinc-lead-silver deposit. The deposit, about 50 miles north of Eagle, is owned by Doyon Ltd.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Juneau, AK.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	Region
Cement (portland): Anchorage Sand and Gravel Co -----	1813 East First Ave. Anchorage, AK 99501	Grind and blend.	Cook Inlet- Susitna.
Gold:			
Alaska Gold Co.-----	Box 640 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Alaska Placer Development Inc. (Hanneman-Knaebel Partnership). GHD Resources Partners Ltd -----	Box 81467 Fairbanks, AK 99708 Box 10499 Fairbanks, AK 99710	Placer ---- ----do ----	Yukon River. Do.
Hoosier Mining Co.-----	General Delivery Rampart, AK 99767 Box 1599 Claypool, AZ 85532	----do ----	Do.
Inspiration Gold Inc.-----	610 East Fourth Ave. Anchorage, AK 99507 Box 1920 Nome, AK 99762	Placer-dredge	Seward Peninsula.
Valdez Creek Mining Co. Inc -----		Placer ----	Yukon River.
Windfall Gold Mining Corp -----		----do ----	Seward Peninsula.
Sand and gravel (construction):			
Anchorage Sand and Gravel Co -----	1813 East First Ave. Anchorage, AK 99501	Pit -----	Cook Inlet- Susitna.
Central Paving Products -----	1301 East 64th Ave. Anchorage, AK 99501	Pit -----	Do.
Fairbanks Sand and Gravel Co -----	Box 686 Fairbanks, AK 99707	Pit -----	Yukon River.
Juneau Ready-Mix Inc -----	Box 270 Juneau, AK 99802	Pit -----	Southeastern Alaska.
U.S. Bureau of Land Management -----	Box 24, 701 C St. Anchorage, AK 99513	Pit -----	Various.
Stone (crushed):			
Alaska Railroad Corp.-----	Box 107500 Anchorage, AK 99510	Pit -----	Do.
Aleutian Constructors -----	3909 Arctic Blvd. Anchorage, AK 99501	Quarries ---	Cook Inlet- Susitna.
Associated Sand & Gravel Co. Inc.-----	Box 3699 Juneau, AK 99803	----do ----	Southeastern Alaska.
Ketchikan Ready-Mix and Quarry Inc ---	Box 8100 Ketchikan, AK 99901	Quarry -----	Do.
U.S. Forest Service, Region 10 -----	Box 1628 Juneau, AK 99802	Quarries ---	Various.
Yutan Construction Co -----	Box 1775 Fairbanks, AK 99707	Quarry -----	Yukon River.
Tin:			
Lost River Mining (Alaska Placer Co.) --	Box 1150 Phoenix, AZ 85001	Placer ----	Seward Peninsula.



# The Mineral Industry of Arizona

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

By Lorraine B. Burgin<sup>1</sup>

The value of nonfuel mineral production in Arizona was \$1.6 billion in 1986, little changed from that of 1985. Metals output comprised about 81% of the total value, a small decline from that of 1985. Copper continued to be nearly three-fourths of Arizona's nonfuel mineral output, although its production and value decreased, in part because of sustained low prices for the metal. Gold and silver, byproducts of copper

production, declined in quantity and value as the copper industry remained in the doldrums and the prices of precious metals remained sluggish. Molybdenum output also fell; however, shipments increased as one company reduced its inventory and another resumed marketing concentrates. Because of cost-cutting measures, changes in ownership, and favorable labor settlements, most copper producers operated at or near profit-

Table 1.—Nonfuel mineral production in Arizona<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons...	138	\$819	186	\$1,503	201	\$1,366
Copper (recoverable content of ores, etc.) metric tons...	746,453	1,100,182	796,556	1,175,995	789,175	1,149,193
Gem stones ----- -----	NA	*2,700	NA	*2,700	NA	2,533
Gold (recoverable content of ores, etc.) troy ounces...	54,897	19,799	52,053	16,535	W	W
Gypsum ----- thousand short tons...	261	2,332	251	1,926	260	1,820
Lead (recoverable content of ores, etc.) metric tons...	W	W	581	244	W	W
Lime ----- thousand short tons...	359	17,304	476	21,226	505	21,016
Molybdenum ----- thousand pounds...	24,013	76,112	24,125	63,389	29,382	75,607
Pumice ----- thousand short tons...	2	21	W	2	2	30
Sand and gravel (construction) ----- do	30,439	101,959	*37,000	*118,000	40,468	140,004
Silver (recoverable content of ores, etc.) thousand troy ounces...	4,247	34,570	4,885	30,007	4,202	22,987
Stone (crushed) ----- thousand short tons...	*5,200	*27,300	5,929	23,111	*5,600	*25,100
Combined value of cement, perlite, pyrites (1984-85), salt (1984, 1986), sand and gravel (industrial), stone (dimension), tin (1984), and values indicated by symbol W	XX	*102,840	XX	95,447	XX	116,379
Total -----	XX	*1,485,938	XX	1,550,085	XX	1,556,035

<sup>\*</sup>Estimated. <sup>†</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



able levels. However, the competitiveness of the U.S. industry continued to be hurt by the strengthening of the U.S. dollar relative to currencies of major copper producing and exporting countries. The average copper price for 1986 in current U.S. dollars was the lowest since 1975.

**Table 2.—Nonfuel minerals produced in Arizona in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Apache -----	Sand (industrial), clays, stone (crushed).
Cochise -----	Copper, gold, silver, stone (crushed).
Coconino -----	Stone (crushed), stone (dimension).
Gila -----	Copper, molybdenum, silver, gold, stone (crushed), clays.
Graham -----	Stone (crushed), pumice.
Greenlee -----	Copper, gold, silver, molybdenum, lead.
Maricopa -----	Stone (crushed), clays.
Mohave -----	Stone (crushed), gold.
Navajo -----	Stone (crushed).
Pima -----	Copper, cement, molybdenum, silver, stone (crushed), gold, clays, lead.
Pinal -----	Copper, molybdenum, silver, gold, gypsum, stone (crushed), perlite, sand (industrial), lead, pyrites.
Yavapai -----	Copper, cement, lime, stone (crushed), silver, clays, gypsum.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Nationally, the State rose from 4th to 3d place in 1986 in value of nonfuel mineral output; Arizona remained 1st in copper with 69% of domestic production value, 2d in molybdenum with 31%, 4th in silver with 12%, and 11th in gold.

In the industrial minerals group, the leading commodities, in descending order of value, were construction sand and gravel, portland cement, crushed stone, and lime. Industrial commodities increasing in value were portland cement, pumice, salt, construction sand and gravel, and crushed stone. Arizona continued to rank first nationally in gem stone output.

**Trends and Developments.**—With depressed economic growth, the copper industry strived to attain profitability. Companies continued to be restructured, labor unions accepted lower wages and benefits, costs were reduced by increasing productivity, and newer mining and processing methods were introduced. As a result, several major firms posted a profit or reached a break-even point by yearend. Ownership of

copper operations in the State was realigned by purchase, merger, and spinoff, and the number of major companies producing copper fell to 6 in 1986, compared with 11 in 1981. To supplement labor-intensive conventional mining and processing, the trend was toward low-cost leaching of waste dumps and low-grade ores and the construction of solvent extraction-electrowinning (SX-EW) facilities for the production of electrowon copper. Environmental problems continued to confront the industry: of seven smelters that operated in 1981, four were active in 1986, and of these, one prepared for permanent closure a year earlier than scheduled, another was assessed fines for emissions violations, and one sought financing for retrofitting to meet air-quality standards.

Employment in the fuels and nonfuels mineral industry dropped from its 1976 high of 26,900 to 10,900 in 1986. The number of workers engaged in the exploration and production copper industry averaged 9,300, down 8% from the average of 1985. The Western Economic Analysis Center at Marana reported that weekly earnings in the copper industry averaged \$538 in 1986, compared with \$581 for all mining, and the total copper industry payroll was about \$260 million, compared with more than \$441 million for all mining.<sup>2</sup>

In July, for the first time in 25 years, five major copper producers with union contracts reached new labor agreements without an industry-wide strike. All contracts reduced wages and benefits, with some having provisions for restoring previously reduced wages or providing a bonus based on increases in the price of copper; most eliminated the cost-of-living allowance. Except for one 4-year agreement, all were for 3 years.

**Exploration Activities.**—Exploration projects in the State focused on precious metals and copper, often in areas of past production. Roddy Resources Inc. and J. Devins Resources Group Inc. prospected and developed the U.S. (Big Horn) Mine in the Big Horn Mountains about 25 miles southwest of Aguila, Maricopa County. The company estimated reserves of 600,000 short tons of 0.08-troy-ounce-per-ton of gold as the open pit and heap leach operation went into production at yearend. Can-Ex Resources Ltd., Vancouver, British Columbia, Canada, explored and evaluated five mines in the same district. DMEA Ltd. conducted surface core drilling at the old Vulture Mine,

Table 3.—Indicators of Arizona business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
Employment and labor force, annual average:				
Population	thousands	3,073	3,193	3,319
Total civilian labor force	do	1,441	1,477	1,586
Unemployment	percent	5.0	6.5	6.9
Employment (nonagricultural):				
Mining total	thousands	13.1	11.9	10.9
Metal mining <sup>1</sup>	do	11.3	9.8	9.1
Manufacturing total	do	172.8	181.6	184.2
Primary metal industries	do	7.0	7.9	7.4
Stone, clay, and glass products	do	7.5	7.8	7.8
Chemicals and allied products <sup>2</sup>	do	3.7	3.7	3.8
Petroleum and coal products <sup>2</sup>	do	1	2	2
Construction	do	97.0	112.1	113.6
Transportation and public utilities	do	59.9	62.9	66.4
Wholesale and retail trade	do	286.3	311.1	325.2
Finance, insurance, real estate	do	72.1	81.0	89.1
Services	do	273.2	299.9	325.9
Government and government enterprises	do	207.5	218.1	226.1
Total	do	1,181.9	1,278.6	1,341.4
Personal income:				
Total	millions	\$36,778	\$40,926	\$44,719
Per capita	do	\$11,969	\$12,818	\$13,474
Hours and earnings:				
Total average weekly hours, production workers	do	40.8	40.9	41.0
Mining (copper ores)	do	41.3	41.6	40.4
Total average hourly earnings, production workers	do	\$9.1	\$9.5	\$9.8
Mining (copper ores)	do	\$13.4	\$13.9	\$13.3
Earnings by industry: <sup>2</sup>				
Farm income	millions	\$549	\$441	\$497
Nonfarm	do	\$25,812	\$28,954	\$31,789
Mining total	do	\$513	\$526	\$512
Metal mining	do	\$384	\$357	\$351
Nonmetallic minerals except fuels	do	\$14	\$14	\$11
Coal mining	do	\$49	\$47	\$51
Oil and gas extraction	do	\$62	\$96	\$99
Manufacturing total	do	\$4,489	\$4,885	\$5,274
Primary metal industries	do	\$230	\$245	\$244
Stone, clay, and glass products	do	\$184	\$210	\$220
Chemicals and allied products	do	\$90	\$92	\$103
Petroleum and coal products	do	\$5	\$6	\$6
Construction	do	\$2,591	\$3,029	\$3,227
Transportation and public utilities	do	\$1,632	\$1,767	\$1,895
Wholesale and retail trade	do	\$4,365	\$4,945	\$5,290
Finance, insurance, real estate	do	\$1,672	\$2,021	\$2,438
Services	do	\$5,712	\$6,495	\$7,352
Government and government enterprises	do	\$4,640	\$5,080	\$5,557
Construction activity:				
Number of private and public residential units authorized <sup>3</sup>	do	79,259	71,820	61,614
Value of nonresidential construction <sup>3</sup>	millions	\$1,536.5	\$1,831.0	\$1,623.4
Value of State road contract awards <sup>4</sup>	do	\$438.0	\$499.0	\$341.0
Shipments of portland and masonry cement to and within the State	thousand short tons	2,001	2,318	2,400
Nonfuel mineral production value:				
Total crude mineral value	millions	\$1,485.9	\$1,550.1	\$1,556.0
Value per capita	do	\$484	\$485	\$469

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

southwest of Wickenburg, Maricopa County, and at the United Verde Extension at Jerome, Yavapai County. Long Lac Mineral Exploration Ltd. surface-drilled for gold at its Montezuma Huron property near Prescott, Yavapai County. Ivy Minerals Inc. rehabilitated and explored the Gold Bug

Mine, 30 miles northwest of Chloride, Mohave County.

Several companies explored for copper, including Pinto Valley Copper Corp., which test-drilled the old Miami copper tailings deposited from 1911 to 1934.

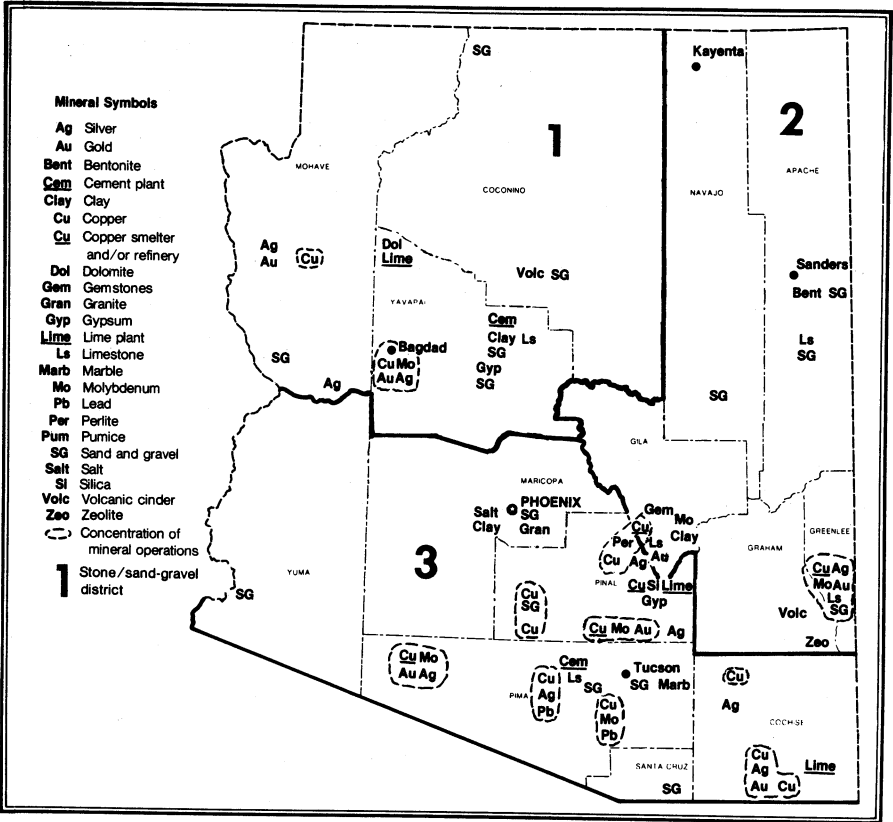


Figure 1.—Principal mineral-producing localities in Arizona.

**Legislation and Government Programs.**—In 1986, the Governor signed several bills relating to the mineral industry. House bill 2038 extended the radiation regulatory agency and board to July 1996. House bill 2109 repealed the requirement that a person be a U.S. citizen to obtain a State prospecting permit; a prospecting permit could be issued to anyone 18 or older, but not to companies unqualified to do business in Arizona. Senate bill 1085 excluded concrete and asphalt plants from the statutory definition of a mine. Senate bill 1185 prescribed a \$5 fee for an affidavit of performance of annual assessment work. House bill 2518 transferred the Division of Environmental Health Services from the Arizona Department of Health Services to a newly organized Department of Environmental Quality. The new department would protect all aspects of the environment, with

special emphasis on ground water as related to garbage, mining waste, sewage, and toxic substances.

The Arizona Bureau of Geology and Mineral Technology, Geological Branch, in fiscal year 1985-86, published Bulletin 196, "Mine Index for Metallic Mineral Districts of Arizona"; Circular 24, "Bibliography for Mineral Districts in Cochise, Graham, and Greenlee Counties, Arizona"; Circular 25, "Bibliography for Metallic Mineral Districts in La Paz, Mohave, and Yuma Counties, Arizona"; and Circular 26, "Bibliography for Metallic Mineral Districts in Pima and Santa Cruz Counties, Arizona."

The Arizona Department of Mines and Mineral Resources published the ninth edition of "Laws and Regulations Governing Mineral Rights in Arizona," generalizing Federal and State mining laws applying within the State.

In accordance with the Federal Land Policy and Management Act of 1976 (Public Law 94-579), the U.S. Bureau of Mines issued mineral land assessment open-file reports on mineral investigations of nine wilderness study areas in Arizona: Dos Cabezas Mountains, Cochise County; Baboquivari Peak, Pima County; Canaan Mountain, Mohave County; Eagletail Mountains in La Paz, Maricopa, and Yuma Counties; Woolsey Peak, Maricopa County; Table Top Mountains in Pinal and Maricopa Counties; Signal Mountain, Maricopa County; Cactus Plain, La Paz County; and Mount Wilson, Mohave County.

The U.S. Bureau of Mines compared the availability of federally owned minerals in Arizona with lands considered favorable for the discovery of mineral resources, to determine the extent to which Federal lands in such areas have been withdrawn from mineral entry by legal action or restricted by

management practice.<sup>3</sup>

The U.S. Bureau of Mines selected the ASARCO Incorporated-Freeport McMoRan Inc. Santa Cruz deposit and the Noranda Lakeshore Mines Inc. Lakeshore deposit, both near Casa Grande, for drilling and data collection in its in situ leach investigation of undisturbed copper deposits. In late September, a \$539,280 Bureau of Mines contract was issued to Science Applications International Corp. to develop an in situ copper mine design manual and to make permeability tests, collect field data, and perform geophysical logging to determine the degree of saturation of the rock. One goal of the project was to construct a pilot plant to ascertain copper recoveries, and another was to determine locations for placement of injection and recovery wells. Cost of the total project was an estimated \$15 to \$20 million.<sup>4</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

**Copper.**—Arizona copper production tonnage and value declined slightly as the average price of U.S. producer cathode fell from \$0.6697 per pound in 1985 to \$0.6605 in 1986.

The major copper companies continued to retrench to meet the heavy losses suffered since 1982 when low copper prices, combined with other depressed metal prices, forced layoffs and other drastic cost-cutting measures. The slimmed-down work force, labor agreements that reduced wages and benefits, corporate restructuring, and improved mining and metallurgical technology allowed several major companies—Asarco, Cyprus Minerals Co., Inspiration Consolidated Copper Co., and Phelps Dodge Corp.—to post profits.

Copper was produced at 24 operations in the following counties, in descending order of output: Greenlee, Pinal, Pima, Gila, Yavapai, and Cochise. Of these, 11 were large-scale conventional mining and concentrating installations treating more than 100,000 short tons of material annually. Most major operations supplemented production by leaching waste dumps or low-grade ores for treatment at precipitate plants and/or SX-EW facilities. Five operations on stand-by continued to produce cement copper at precipitate facilities on the properties.

Six small base and precious metals operations recovering copper from old tailings or lode deposits included Phelps Dodge's Golden Prince in Cochise County, Shamrock Enterprises' Ash Peak Mine in Greenlee County, Little Hill Mines Inc.'s Reymert Mine and McFarland & Hullinger's tailings operation in Pinal County, and Nor-Quest Arizona Inc.'s Gladiator-War Eagle Mine in Yavapai County.

In its annual summary of the primary copper industry of Arizona, the Arizona Department of Mines and Mineral Resources provided much information on the copper industry, including copper and molybdenum production listed by producer, copper reserves, mine and smelter capacities, and other information.<sup>5</sup>

The following examples were highlights of the State's copper industry during the year.

Anamax Mining Co., a 50-50 joint venture with Atlantic Richfield Co.'s Anaconda Minerals Co. and AMAX Inc., proceeded with reclamation work at its permanently closed Twin Buttes operation south of Tucson. A liquidation and development company, Park Co. of West Virginia, was scheduled to purchase the mine equipment and facilities and to develop certain properties. Anamax planned to terminate its 10-year-old partnership with Asarco in the Eisenhower Mining Co. on April 30, 1987. Asarco would

purchase the Anamax portion of the Eisenhower mineral reserves, some equipment, and buildings.

Asarco operated the Mission Complex south of Tucson; the Silver Bell Unit northwest of Tucson; the Hayden Unit, a smelter facility, in Gila County; and at yearend, the Ray Mine in Gila and Pinal Counties. The Mission Complex included the adjacent Eisenhower, Mission, Pima, and San Xavier open pit mines and Mission concentrator.

At the Mission operation, mining costs were lowered from \$0.90 to \$0.60 per pound with consolidation of adjoining mining operations into one pit, modernization of the mill, and an improved labor contract.

Cyprus Minerals purchased Duval Corp.'s Esperanza-Sierrita complex south of Tucson, Pima County, and the Mineral Park operation north of Kingman, Mohave County, on March 31. After the purchase, Sierrita produced copper at about 75% of capacity the remainder of the year. With the acquisition of the Sierrita operation, Cyprus Minerals became the third largest copper producer in the United States and the third largest molybdenum producer in the world. Cyprus Minerals also operated Cyprus Bagdad Copper Co., Yavapai County. During the year, its Cyprus Johnson Copper Co. leaching project at Benson, Cochise County, was shut down permanently and the SX-EW plant transferred to Sierrita.

Inspiration Consolidated Copper, a subsidiary of Inspiration Resources Corp., shut down its sulfide concentrator and limited its operations to mining and treating oxide and leachable sulfide ores. Ninety-one percent of concentrates and precipitates treated at the smelter were tolled or purchased material. Contributing to cost reductions at the operation was the 3-year labor contract ratified in July, which reduced hourly wages by about 23%. The U.S. Environmental Protection Agency (EPA) filed suit against Inspiration Consolidated asserting that leakage from mine wastewater being held in Webster Lake was contaminating the ground water. The company was one of several mining companies suspected of being the source of a plume of sulfates and trace metals moving in ground water toward Roosevelt Lake.

In November, Kennecott, a subsidiary of Standard Oil Co., sold its Ray Mines Div. to Asarco for \$72 million in cash, plus a share in future revenues resulting from increases in the price of copper. Acquisition of the Ray Mine increased Asarco smelter's inter-

nal supply of ores, concentrates, and precipitates by 60%.

Newmont Mining Corp. owned two subsidiaries in Arizona: Magma Copper Co., with its San Manuel Div. and inactive Superior Div., and the Pinto Valley Copper. Continued operating losses at Magma Copper and the impending retrofit of its San Manuel smelter and acid plant to meet State and Federal environmental requirements led Newmont to restructure its copper operations.

On September 29, Newmont announced Magma Copper would be reorganized and spun off as an independent company. Under the plan, Pinto Valley Copper became a division of Magma Copper on November 5. The restructuring of Magma Copper would enable the company to obtain financing for a \$267 million capital expenditure plan at San Manuel to retrofit its smelter to limit atmospheric emissions, construct a new oxygen plant for the new Outokumpu flash furnace, complete the SX-EW in situ leaching project, modernize its concentrator, expand its refinery capacity, and develop its deep Kalamazoo ore body.

Magma Copper employed more than 4,000 workers at its San Manuel and Pinto Valley operations and, in midyear, agreed to a 3-year labor contract that resulted in an overall reduction in labor costs at both properties.

The Noranda Lakeshore Mines in situ leach of its underground mine on the Tohono O'Odham Indian Reservation, Pinal County, continued to decline in output.

Phelps Dodge, the Nation's leading copper producer, registered a \$61.4 million net income, compared with a lesser profit in 1985, and a \$267.8 million loss in 1984. As part of its restructuring program to recover from 1984 losses, the company completed the \$75 million sale of a 15% interest in its Morenci Mine, concentrators, and related facilities to Sumitomo Metal Mining Arizona Inc., a jointly owned Delaware subsidiary of Sumitomo Metal Mining Co. Ltd. and Sumitomo Corp., both of Japan. The transaction did not include the closed Morenci smelter.

Major cost reduction projects at Morenci included converting mine transportation from rail to computerized-dispatch truck haulage and mining above-average-grade ore. Additional production and further cost reductions were expected after Morenci completes its new \$90 million SX-EW facility by yearend 1987. The Arizona Depart-

ment of Health Services studied the Phelps Dodge application for a ground water permit relating to its new plants.

Under an October consent decree with the State and EPA, Phelps Dodge agreed to construct flood control and storm runoff facilities in lower Chase Creek and the San Francisco River. The \$9 million program, designed to protect downstream water quality, was scheduled to be completed by January 1988.

At other Arizona properties, Phelps Dodge continued to operate the low-cost

Copper Queen leaching and precipitation project. Reopening of the Ajo operation in Pima County and development of the Safford and Copper Basin projects in Graham and Yavapai Counties, respectively, awaited significantly higher and more stable copper prices. In October, Phelps Dodge agreed to close its Douglas smelter permanently on January 15, 1987. The firm's production in Arizona and New Mexico exceeded its smelter capacity at Douglas and at Hidalgo, NM; concentrates were sold to other smelters or toll smelted.

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

Year	Arizona copper production		U.S. copper production		Arizona Percent of U.S. copper production
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	
1982	769,521	\$1,235,055	1,146,975	\$1,840,856	67.1
1983	678,216	1,144,285	1,038,098	1,751,476	65.3
1984	746,453	1,100,182	1,102,613	1,625,116	67.7
1985	796,556	1,175,995	1,105,758	1,632,483	72.0
1986	789,175	1,149,193	1,147,277	1,670,660	68.8

**Table 5.—Arizona: 15 leading copper-producing mines in 1986, in order of output**

Rank in 1986	Rank in 1985	Mine	County	Operator	Source of copper
1	1	Morenci	Greenlee	Phelps Dodge Corp	Copper-molybdenum ore, concentrated and leached.
2	3	San Manuel	Pinal	Magma Copper Co.	Copper-molybdenum ore and retreated slag, concentrated and leached.
3	4	Ray	do	ASARCO Incorporated	Copper ore, concentrated and leached.
4	6	Pinto Valley	Gila	Pinto Valley Copper Corp	Copper-molybdenum ore, concentrated and leached.
5	2	Sierrita <sup>1</sup>	Pima	Cyprus Sierrita Corp	Do.
6	5	Bagdad	Yavapai	Cyprus Bagdad Copper Co	Do.
7	7	Inspiration	Gila	Inspiration Consolidated Copper Co.	Do.
8	15	Mission	Pima	ASARCO Incorporated	Copper ore, concentrated.
9	8	Eisenhower	do	do	Do.
10		Pima	do	do	Do.
11	11	San Xavier	do	do	Do.
12	14	Miami	Gila	Pinto Valley Copper Corp	Copper ore, leached.
13	10	Lakeshore	Pinal	Noranda Lakeshore Mines Inc.	Do.
14	13	Silver Bell	Pima	ASARCO Incorporated	Do.
15		Ox-Hide	Gila	Inspiration Consolidated Copper Co.	Do.

<sup>1</sup>In 1986, owing to change of ownership, Sierrita and Esperanza have been combined to form one unit. All future reporting will reflect this change.

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

Mine	Ore mined (thousand metric tons)		Waste material removed (excluding material placed in leach dumps) (thousand metric tons)		Material placed in leach dumps (thousand metric tons)		Total copper produced <sup>1</sup> (metric tons)	
	1985	1986	1985	1986	1985	1986	1985	1986
	<b>OPEN PIT</b>							
Morenci	33,492	W	6,645	NA	16,152	NA	241,416	W
Ray	11,442	9,874	--	--	25,975	20,949	81,809	90,848
Pinto Valley	17,761	20,172	3,514	79,995	14,518	177,664	77,018	81,664
Sierrita	32,982	<sup>2</sup> 26,928	16,676	<sup>2</sup> 6,413	3,514	<sup>2</sup> 494	98,078	<sup>2</sup> 80,737
Bagdad	18,250	17,919	6,265	5,457	1,893	4,403	79,755	78,853
Inspiration	7,401	W	--	NA	--	NA	70,858	W
Mission	302	2,663	497	1,686	--	--	3,154	19,285
Eisenhower	7,115	3,559	12,317	3,570	--	--	43,687	16,738
Pima	213	1,410	--	1,198	--	--	1,136	12,678
San Manuel	--	6,103	--	10,343	--	6,103	--	9,945
San Xavier	1,266	1,374	1,750	763	--	--	5,525	7,196
Miami	--	--	--	--	--	--	3,657	3,451
Silver Bell	--	--	--	--	--	--	4,036	3,244
Johnson	--	--	--	--	--	--	2,812	2,211
Esperanza	4,130	( <sup>2</sup> )	--	( <sup>2</sup> )	--	( <sup>2</sup> )	4,657	( <sup>2</sup> )
<b>UNDERGROUND</b>								
San Manuel	15,783	16,332	--	791	--	--	87,132	92,126
Lakeshore	--	--	--	--	--	--	6,148	3,221

NA Not available. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Gross metal content.

<sup>2</sup>In 1986, owing to change of ownership, Sierrita and Esperanza have been combined to form one unit. All future reporting will reflect this change.

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

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
	1984, total	24		--	125,687,818	54,897	\$19,799,044
1985, total	17	2	127,209,540	52,053	16,535,105	4,885,310	30,006,552
<b>1986:</b>							
Cochise	2	--	W	W	W	W	W
Gila	3	--	W	W	W	W	W
Greenlee	1	--	W	W	W	W	W
Maricopa	1	1	W	W	W	W	W
Pima	5	1	W	W	W	W	W
Pinal	5	--	W	W	W	W	W
Yavapai	2	--	W	W	W	W	W
Total	19	2	<sup>3</sup> 127,946,022	W	W	<sup>3</sup> 4,202,316	<sup>3</sup> 22,986,669
<b>Copper</b>							
	Metric tons	Value	Metric tons	Value	Metric tons	Value	Total value
1984, total	746,453	\$1,100,181,923	W	W	--	--	W
1985, total	796,556	1,175,995,140	581	\$244,313	--	--	\$1,222,781,110
<b>1986:</b>							
Cochise	W	W	--	--	--	--	W
Gila	W	W	--	--	--	--	W
Greenlee	W	W	--	--	--	--	W
Maricopa	--	--	--	--	--	--	W
Pima	W	W	W	W	--	--	W
Pinal	W	W	--	--	--	--	W
Yavapai	W	W	--	--	--	--	W
Total	<sup>3</sup> 789,175	<sup>3</sup> 1,149,193,164	W	W	--	--	<sup>3</sup> 1,187,525,974

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Excludes operations at which metals were recovered only from tailings or precipitates.

<sup>2</sup>Excludes gravel washed.

<sup>3</sup>Includes items indicated by symbol W.

**Table 8.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by class of ore or other source material**

Source	Number of mines <sup>1</sup>	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold-silver	3	W	W	W	W	--	--
Silver	1	W	--	W	W	--	--
Total	4	W	W	W	W	--	--
Copper	15	<sup>2</sup> 127,328,383	<sup>2</sup> 36,951	<sup>2</sup> 4,093,610	<sup>2</sup> 746,089	W	--
Other lode material:							
Gold tailings	--	72,182	1,334	29,020	128	--	--
Gold-silver tailings	--	W	W	W	W	--	--
Silver tailings	--	W	W	W	--	--	--
Copper precipitates	2	58,675	--	--	39,856	--	--
Copper tailings	1	W	--	--	W	--	--
Total	3	W	W	W	W	--	--
Total lode	19	<sup>2</sup> 127,945,906	W	W	<sup>2</sup> 789,175	W	--
Placer	2	--	W	W	--	--	--
Grand total	21	127,945,906	W	<sup>2</sup> 4,202,316	789,175	W	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Detail may not add to totals shown because some mines produce more than one class of material. Operations from which metals are recovered only from tailings or precipitates are not counted as producing mines.

<sup>2</sup>Includes items indicated by symbol W.

**Table 9.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Acid leaching (vat, tank, heap)	--	--	<sup>1</sup> 96,317	--	--
Cyanidation	W	--	--	--	--
Smelting of concentrates <sup>2</sup>	W	4,085,428	652,791	W	--
Total	W	4,085,428	749,108	W	--
Direct smelting of:					
Ore	W	W	W	--	--
Precipitates	--	--	39,856	--	--
Tailings <sup>3</sup>	W	W	W	--	--
Total	W	W	<sup>4</sup> 40,067	--	--
Total lode material	W	W	789,175	W	--
Placer	W	W	--	--	--
Grand total	W	<sup>4</sup> 4,202,316	<sup>4</sup> 789,175	W	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes copper recovered by electrowinning process.

<sup>2</sup>Includes metal recovered from tailings.

<sup>3</sup>Excludes metal recovered from tailings by concentration.

<sup>4</sup>Includes items indicated by symbol W.

**Gold.**—Gold continued to be recovered principally as a byproduct of copper production. Although total output of placer and lode gold declined more than one-fifth in quantity, its value decreased much less as the average price of the metal rose from

\$317.66 per troy ounce in 1985 to \$368.24 in 1986. Listed in descending order of production, operations recovering gold included San Manuel, Morenci, McFarland & Hullinger tailings dump (Pinal County), Sierrita, Mission, Ray, Eisenhower, Golden Prince of



**Phelps Dodge** (Cochise County), Pima, **Gladiator-War Eagle** of Nor-Quest Arizona (Yavapai County), San Xavier, Ash Peak of Shamrock Enterprises (Greenlee County), and Diumich & Associates (Cochise County). Placer gold was mined in Pima County.

In October, the Cyprus Minerals board of directors approved development of its planned Cyprus Gold Div.'s Copperstone Mine about 18 miles south of Parker, La Paz County. The company estimated reserves of 4.4 million short tons of ore averaging 0.077 troy ounce of gold per ton; a projected total of 317,000 contained ounces.<sup>6</sup> Production of about 60,000 ounces per year was scheduled to begin in the third quarter of 1987 and was expected to last at least 5 years.

Nor-Quest Arizona, nearly three-fourths owned by Nor-Quest Resources Ltd. of Nanaimo, British Columbia, Canada, brought the Gladiator-War Eagle Mine back into production in January. The mine is in the Bradshaw Mountains, 30 miles south of Prescott, near Crown King, Yavapai County. Ores from the underground mine were processed through a 100-ton-per-day flotation mill and the concentrates trucked to the Cominco Ltd. smelter at Trail, British Columbia, Canada. The company estimated proven and probable reserves of 200,000 tons of 0.54 ounce of gold and 3.5 troy ounces of silver.<sup>7</sup>

In late 1986, J. Devins Resources and its partner, Roddy Resources of Vernon, British Columbia, Canada, commenced heap-leaching operations at the U.S. (Big Horn) Mine in the Big Horn Mountains of western Maricopa County.

**Lead.**—The small amount of lead produced as a byproduct of copper ore beneficiation declined substantially when several operations ceased recovering the product. Although the average price of lead rose from about \$0.19 per pound in 1985 to \$0.22 in 1986, the low price of the metal during the first 3 months of 1986 and high inventories contributed to withholding its output. Production was reported from the Eisenhower, Mission, and San Xavier mines.

**Molybdenum.**—Molybdenum recovered as a coproduct or byproduct from copper ores in the State declined about 9%. Total shipments increased nearly 22% in quantity and about 19% in value as the average price of molybdc oxide (per pound of contained molybdenum) declined from \$3.33 in 1985 to \$3.11 in 1986. Domestic shipments from four mines increased about 24%, and exports from three mines rose more than

12%. Molybdenum was recovered as a coproduct of copper production at the Sierrita Mine (the leading producer in the State). Listed in descending order of quantity, operations obtaining molybdenum as a byproduct of copper production were the Bagdad, San Manuel, Pinto Valley, and Morenci mines.

**Rhenium.**—The rhenium compound ammonium perrhenate was recovered by roasting molybdenum concentrates, a byproduct of copper production from porphyry copper. Cyprus Minerals' Sierrita Mine continued as the only domestic producer in 1986. Consumption of rhenium was about the same as that in 1985; rhenium was used principally as a bimetallic platinum-rhenium catalyst in the production of low-lead and lead-free high-octane gasoline.

**Silver.**—Arizona silver production continued to decline in quantity and value as the price for the metal fell from \$6.14 per troy ounce in 1985 to \$5.47 in 1986. Most of the silver produced in the State was recovered as a byproduct of copper production at nine operations; other output was obtained from ores mined principally for smelter flux. Leading silver producers were the Sierrita, Morenci, Bagdad, Mission, San Manuel, Pima, Eisenhower, and Ray Mines, followed by the San Xavier, Diumich & Associates, Reymert, McFarland & Hullinger, Ash Peak, Gold Hill, Gladiator-War Eagle, and Golden Prince operations.

**Uranium-Vanadium.**—No vanadium production was reported in Arizona in 1986; however, exploration continued for uranium contained in breccia pipes in the northern areas, particularly in the Arizona Strip north of the Grand Canyon. Pathfinder Mines Corp. prepared to drill a claim 10 to 12 miles north of the Grand Canyon Toroweap overlook. Energy Fuels Nuclear Inc. continued to operate its Hack 2, Hack 3, and Pigeon uranium mines in the northern part of the State and to develop the Kanab-North and Pinenut Mines north of the Grand Canyon. In November, development of the company's Canyon Mine project near Tusayan, southeast of Grand Canyon Village in the Kaibab National Forest, was stalled when the U.S. Forest Service's approval of the plan of operations was opposed by certain environmental groups and the Havasupai Indian tribe.

#### INDUSTRIAL MINERALS

**Cement.**—Production of finished gray portland cement increased about 9%, while

the price rose only a fraction. Output of white cement increased about 4%.

Arizona Portland Cement Co., a division of California Portland Cement Co., in turn a subsidiary of CalMat Co., and Phoenix Cement Co., a division of Gifford-Hill & Co. Inc., continued to produce cement in the State. Both companies marketed a general-use and moderate-heat gray portland cement and a masonry cement. Phoenix Cement also produced and sold a white portland cement and a pozzolan cement.

In descending order of tonnage, raw materials consumed were limestone, gypsum, clays, fly ash, iron ore, and other materials. Fuels and energy consumed in the manufacture of cement were natural gas, electrical energy, and coal.

According to CalMat Co.'s 1986 annual report, Arizona Portland Cement's Rillito plant operated at near capacity. In 1986, a \$3 million kiln modification reduced costs and resulted in a 20% increase in production; also, a \$6 million program was authorized to update the plant's grinding facilities. The company estimated that proven and probable limestone reserves near the Rillito plant totaled more than 105 million short tons, sufficient to operate the plant for approximately 64 years.

At its 630,000-ton-per-year-capacity Clarkdale plant, Phoenix Cement reported that the first year of operating the world's first full-stream bulk material analyzer provided better control and analysis of the plant's raw material stockpile.<sup>8</sup>

**Clays.**—Arizona clay output gained about 8%; however, its value declined about 9% as the average unit value of all clays declined to \$6.79 in 1986, compared with \$8.08 in 1985. Common clay production rose about 20% in quantity and 27% in value; however, bentonite output decreased about 51% in tonnage and 47% in value. The principal common clay producers were Phoenix Brick Yard's Tolleson Pit in Maricopa County and Pantano Pit in Pima County, Arizona Portland Cement's Pantano Pit in Pima County, Phoenix Cement's pit in Yavapai County, and Magma Copper's Superior Pit in Pinal County. Principal uses for common clay included portland cement and face brick. Nonswelling bentonite was mined at Harshaw/Filtrol Partnership's Cheto Pit in Apache County, and Superior Companies' Arizona Gypsum Corp.'s Verde Pit in Yavapai County. High-calcium nonswelling bentonite was used for desiccants, vegetable oils, and animal feed. McKusick Mosaic Co.

mined a swelling bentonite for medical, pharmaceutical, and cosmetic purposes.

**Gem Stones.**—Arizona continued to lead the Nation with 36% of gem stone output. A small but distinctive deposit of vanadinite on the J. C. Holmes claim in the southeastern Santa Rita Mountains, Santa Cruz County, was described as one of Arizona's premier occurrences of the mineral specimen.<sup>9</sup>

**Gypsum.**—Although crude gypsum output increased in tonnage, its value declined; calcined gypsum production remained nearly the same in quantity and value. National Gypsum Co. quarried and crushed crude gypsum at Feldman, near Winkelman, Pinal County, and calcined gypsum for manufacturing wallboard at its Gold Bond Building Products Div. plant in Phoenix. Pinal Gypsum Co. quarried agricultural gypsum at its White Cross Mine 4 miles north of Mammoth, Pinal County. Superior Companies quarried gypsum for use as a cement additive 4 miles southeast of Camp Verde, Yavapai County.

**Lime.**—Production of lime increased 6%; however, its value declined slightly. Genstar Lime Co., with its quarries at Nelson and plant at Peach Springs, Yavapai County, was the leading producer of lime used for cement, followed by Can-Am Corp.'s Paul Lime Div. near Douglas, Cochise County, and Magma Copper's San Manuel operation, Pinal County, both of which manufactured lime for the copper industry. Imasco Ltd., Montreal, Quebec, Canada, acquired Genstar Corp. and its subsidiary Genstar Lime Co., San Mateo, CA, in April. On December 4, Genstar Lime was sold to Chemical Lime Inc., Fort Worth, TX, and L. HOIST Investments Inc., a Delaware corporation and indirect subsidiary of L. HOIST Group, Liège, Belgium. The name was changed to Chemstar Inc.; Chemstar acquired Can-Am's Paul Lime Div. on December 24.

**Perlite.**—Crude perlite output declined about 5% in quantity, and its value decreased about 1%. Of the six States mining and processing perlite ore, Arizona, with minor production, ranked second, after New Mexico.

Used as a filtering aid for pharmaceuticals, chemicals, sugar, and beverages, and as an agriculture fertilizer carrier, perlite was mined in Arizona by two companies. Harborlite Inc. open pit mined perlite near Superior, Pinal County, and sized the product at its plant 2 miles west of Superior.

**Nord-Sil-Flo Inc.** obtained perlite ore from its Chicago Pit (Old Cliff) 2 miles southwest of Superior and crushed the material at its plant in Superior. Nord-Sil-Flo became a wholly owned subsidiary of Nord Resources Corp., Dayton, OH, in 1986.

**Therm O Rock Industries** in Chandler, Maricopa County, continued to increase production of expanded perlite for plaster aggregate, insulation, and horticultural aggregate. Ores were obtained from sources in Arizona, California, and New Mexico.

**Pumice.**—A small amount of pumice continued to be mined in Arizona. Output increased substantially in quantity and value at Gila Valley Block Co.'s Pumice No. 2 quarry 25 miles east of Safford. The product was used principally for landscaping, decorative building block, and insulation.

**Salt.**—Southwest Salt Co., a subsidiary of Morton Thiokol Inc., solution-mined the Luke Salt deposit at Glendale, Maricopa County, and recovered the salt product in solar evaporation ponds. Salt was marketed for agricultural and industrial uses and water softeners.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter con-

tains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production in 1986 gained about 9% in quantity and nearly 19% in value over 1985 estimates. The 92 producers shipped construction sand and gravel from 130 pits and 124 operations in the following counties, listed in descending order of tonnage: Maricopa, Pima, Pinal, Cochise, Yavapai, Coconino, Navajo, Mohave, Santa Cruz, Graham, Gila, La Paz, and Greenlee.

The leading producers included the Tanner Companies, Union Rock & Materials Corp., CalMat Co. of Arizona, Salt River Sand & Rock, Baseline Materials Inc., Century Materials, Edward C. Levy Co. (Mesa Materials Inc.), Allied Concrete Inc., Granite Construction Co., and Johnson-Stewart-Johnson Mining Co. Inc., most having operations in Maricopa and/or Pima Counties. In 1986, Blue Circle West Inc. became the owner of Johnson-Stewart-Johnson Mining and CalMat Co. acquired Allied Concrete and Materials Co., a major producer of concrete and aggregates in Phoenix, and consolidated the company with CalMat Co. of Arizona.

**Table 10.—Arizona: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	6,441	\$24,893	\$3.86
Plaster and gunite sands -----	212	763	3.60
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	1,810	5,845	3.23
Asphaltic concrete aggregates and other bituminous mixtures -----	8,960	39,750	4.44
Road base and coverings <sup>1</sup> -----	10,232	27,839	2.72
Fill -----	3,213	8,895	2.77
Snow and ice control -----	1	1	1.00
Other -----	390	1,361	3.49
Other unspecified <sup>2</sup> -----	9,208	30,657	3.33
Total or average -----	<sup>3</sup> 40,468	140,004	3.46

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Industrial sand production declined substantially as Arizona Silica Sand Co. near Houck, Apache County, became the only producer. The hydraulic fracturing sand produced was used to improve output in New Mexico and California oil and natural gas deposits.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Crushed stone production was estimated to have declined about 6% in quantity, but value increased about 9%. Arizona Portland Cement completed a new rock-crushing facility at its quarry near the Rillito cement plant, near Tucson. The new plant processed aggregates from material unusable for the cement production.

**Sulfuric Acid.**—Arizona ranked second after New Mexico in production of byproduct sulfuric acid in 1986. The State's copper industry supplied 44% of the Nation's byproduct sulfuric acid. Production in the State increased about 2%, to 1,129,543 short tons; its value rose about 13%, to \$12,983,000 tons.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. produced exfoliated vermiculite at its plant in Phoenix, Maricopa County; the crude vermiculite was shipped in from out of State. The product was marketed for use principally in fireproofing, block insulation, and horticulture applications, followed by loose-fill insulation, plaster, and concrete

aggregate applications.

**Zeolites.**—Four companies were active at the Bowie chabazite deposit in Graham County. The largest producer, the Linde Div. of Union Carbide Corp., introduced a new product, based on Bowie chabazite, for use in automotive mufflers to absorb acids. In its first shipment since 1978, Norton Co. shipped a high-calcium chabazite for processing into extrudates, powders, and aggregates. NRG Inc. marketed a chabazite for use in hazardous-waste storage facilities, and GSA Resources Inc. shipped powders, granules, and crude chabazite to mining companies for removing heavy metals from mine and metallurgical plant effluents.<sup>10</sup> East-West Minerals Inc. purchased Anaconda Minerals Bowie deposit.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.

<sup>2</sup>Leaming, G. F. The Copper Industry's Impact on the Arizona Economy 1986. West. Econ. Anal. Cent., Marana, AZ, June 1987, 32 pp.

<sup>3</sup>McColly, R. A., and N. B. Anderson. Availability of Federally Owned Minerals for Exploration and Development in Western States: Arizona, 1986. BuMines Spec. Publ., 1987, 27 pp.

<sup>4</sup>Walenga, K. USBM In Situ Leaching Project in Arizona Is Moving Ahead. Southwestern Pay Dirt, No. 569, Nov. 1986, pp. 12A-13A.

<sup>5</sup>Beard, R. R. The Primary Copper Industry of Arizona in 1986. AZ Dep. Mines and Miner. Resour. Spec. Rep. 10, Jan. 1988, 68 pp.

<sup>6</sup>Epler, B. Morris-Knudsen Gets Mining Contract at Copperstone. Southwestern Pay Dirt, No. 577, July 1987, p. 6A.

<sup>7</sup>Walenga, K. Nor-Quest Resources Gets Operation Lined Out. Southwestern Pay Dirt, No. 564, June 1986, p. 4A.

<sup>8</sup>Wells, J. Plant Adds Bulk Material Analyzer. Rock Prod., v. 90, No. 4, Apr. 1987, pp. 32-34.

<sup>9</sup>Novack, G., and W. W. Besse. Vanadinite from the J. C. Holmes Claim, Santa Cruz County, Arizona. Mineral Rec., No. 2, Mar.-Apr. 1986, pp. 111-115.

<sup>10</sup>Eyde, T. H. Zeolites. Min. Eng., v. 39, No. 6, June 1987, pp. 422-423.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Arizona Portland Cement Co., a division of California Portland Cement Co., a subsidiary of CalMat Co. <sup>1 2</sup>	Box 338 Rillito, AZ 85246	Quarry and dry-process, 4-rotary-kiln plant.	Pima.
Phoenix Cement Co., a division of Gifford-Hill & Co. Inc. <sup>1 2</sup>	Box 428 Clarkdale, AZ 86324	Quarry and dry-process, 3-rotary-kiln plant.	Yavapai.
<b>Cinder (volcanic):</b>			
Flagstaff Cinder Sales Inc. -----	Old Highway 66 Box 2796 Flagstaff, AZ 86003	Quarry -----	Coconino.
Superlite Builders Supply, a subsidiary of U.S. Industries Inc.	Box 40159 Flagstaff, AZ 86004	Open pit mine and crushing plant.	Do.
<b>Clays:</b>			
Harshaw/Filtrol Partnership, of Kaiser Aluminum & Chemical Corp. and Chevron Corp.	Box 155 Sanders, AZ 86512	Open pit mine -----	Apache.
McKusick Mosaic Co -----	Route 1, Box 35-D Globe, AZ 85501	Surface mine -----	Gila.
Phoenix Brick Yard -----	1814 South 7th Ave. Phoenix, AZ 85007	Open pit mine -----	Maricopa and Pima.
United Desiccants, a division of United Catalyst Inc.	Box 32370 Louisville, KY 40232	Surface strip mine -----	Apache.

See footnotes at end of table.

Table 11.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Copper:</b>			
ASARCO Incorporated:			
Hayden Unit -----	Box 98 Hayden, AZ 85235	Smelter and acid plant ---	Gila.
Mission Complex <sup>3 4 5</sup> -----	Box 111 Sahuarita, AZ 85629	Open pit mines and mill --	Pima.
Ray Unit <sup>3 5 6</sup> -----	Box 9 Hayden, AZ 85235	Open pit mine, leach dumps, precipitation, vat- leaching, solvent ex- traction-electrowinning plants, smelter.	Gila and Pinal.
Silver Bell Unit -----	Silver Bell, AZ 85270 ---	Open pit mine, mill, leach dumps, precipitation plant.	Pima.
Cyprus Metals Co., a division of Cyprus Minerals Co.:			
Cyprus Bagdad Copper Co. <sup>5 6</sup> -	Box 245 Bagdad, AZ 86321	Open pit mine, mill, dump leach, solvent extraction- electrowinning plant.	Yavapai.
Cyprus Sierrita Corp. (formerly Duval Corp., a subsidiary of Pennzoil Co.) <sup>3 5 6</sup>	Box 527 Green Valley, AZ 85622	Open pit mines, mill, leach dumps, precipitation plant, solvent extraction- electrowinning plant.	Pima.
Inspiration Consolidated Copper Co.	Box 1559 Claypool, AZ 85532	Open pit mines, mill, dump leaching, solvent extrac- tion plant, electro- winning-electrorefining tankhouse, custom smelter, sulfuric acid plant, continuous-cast-rod fabrication plant.	Gila.
Magma Copper Co., a subsidiary of Newmont Mining Corp.:			
San Manuel Div. <sup>1 3 5 6 7</sup> -----	Box M San Manuel, AZ 85631	Underground mine, mill, smelter, refinery, contin- uous-cast copper rod plant.	Pinal.
Pinto Valley Div -----	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, in-place leaching, precipitation plants, sol- vent extraction-elec- trowinning plants.	Gila.
Noranda Lakeshore Mines Inc., a subsidiary of Noranda Mines Ltd.	Box C-6 Casa Grande, AZ 85222	In situ mine and sol- vent extraction-elec- trowinning plant.	Pinal.
Phelps Dodge Corp.:			
Corporate Headquarters -----	2600 North Central Ave. Phoenix, AZ 85004-3015		
Copper Queen Branch -----	Box 99 Bisbee, AZ 85603	Underground mine, leach dumps, in-place leaching, precipitation plant.	Cochise.
Morenci Branch <sup>3 5 6</sup> -----	Morenci, AZ 85540 ----	Open pit mines, mills, tail- ings leach plant, leach dumps, precipitation plant, smelter.	Greenlee.
<b>Gypsum:</b>			
National Gypsum Co.:			
Gold Bond Building Products Div.	Box 20863 Phoenix, AZ 85036	Plant -----	Maricopa.
Winkelman Gypsum Pit -----	Star Route, Box 3990 Winkelman, AZ 85292	Open pit mine and crushing plant.	Pinal.
Pinal Gypsum Co -----	Box 99 Coolidge, AZ 85228	Open pit mine -----	Do.
Superior Companies <sup>1 2</sup> -----	1700 North 7th St., No. 5 Phoenix, AZ 85005	Quarries and plant -----	Apache, Pinal, Yavapai.
<b>Lime:</b>			
Can-Am Corp., Paul Lime Div., a subsidiary of Chemstar Inc. <sup>2</sup>			
Chemstar Inc -----	Drawer T Douglas, AZ 85607	Quarry and 3 lime kilns --	Cochise.
	Box 197 Peach Springs, AZ 86434	Quarries and plant -----	Yavapai.
<b>Perlite:</b>			
Harborlite Inc -----	Box 960 Superior, AZ 85273	Open pit mine and plant --	Pinal.
Nord-Sil-Flo Inc., a subsidiary of Nord Resources Corp.	Box 127 Superior, AZ 85273	--- do -----	Do.
<b>Pumice:</b>			
Gila Valley Block Co -----	Box 465 Safford, AZ 85546	Open pit mine -----	Graham.
<b>Salt:</b>			
Southwest Salt Co., a subsidiary of Morton Thiokol Inc., Morton Salt Div.	13000 West Glendale Ave. Glendale, AZ 85307-2408	Solar evaporation of brine from wells.	Maricopa.

See footnotes at end of table.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel:</b>			
Allied Concrete Inc -----	Box 14737 11923 West Indian School Rd. Phoenix, AZ 85031	Pits -----	Maricopa.
Baseline Materials Inc -----	1533 North Alma School Rd. Suite 10 Mesa, AZ 85201	-----do-----	Do.
Blue Circle West Inc. (formerly Johnson-Stewart-Johnson Mining Co. Inc.) -----	2625 South 19th Ave. Phoenix, AZ 85009	-----do-----	Do.
CalMat Co. of Arizona, a subsidiary of California Portland Cement Co., a subsidiary of CalMat Co. Century Materials -----	1801 East University Dr. Box 52012 Phoenix, AZ 85036	Pits and plants -----	Do.
	2156 East 1st St. Box 3175 Tempe, AZ 85281	Pits -----	Do.
Granite Construction Co. -----	4115 East Illinois Box 27566 Tucson, AZ 85726	Pits and plants -----	Pima.
Mesa Materials Inc -----	3410 North Higley Rd. Mesa, AZ 85205	Pits -----	Maricopa.
Salt River Sand & Rock -----	Box 728 Mesa, AZ 85201	-----do-----	Do.
Tanner Companies -----	3640 South 19th Ave. Box 52124 Phoenix, AZ 85072	Pits and plants -----	Coconino, La Paz, Maricopa, Pima, Pinal, Yavapai, Yuma, Maricopa and Pima.
Union Rock & Materials Corp ---	2800 South Central Ave. Box 8007 Phoenix, AZ 85066	-----do-----	
<b>Stone:</b>			
<b>Crushed:</b>			
Andrada Marble Co -----	4901 East Drexel Rd. Tucson, AZ 85706	Quarry -----	Pima.
Arizona Granite -----	7401 West Villa Rita Dr. Peoria, AZ 85345	-----do-----	Maricopa.
Madison Granite Supplies ---	7050 Grand Ave. Glendale, AZ 85301	Quarry and plant -----	Do.
Red Mountain Mining Inc ---	4250 North Bush Hwy. Mesa, AZ 85205	-----do-----	Do.
<b>Dolomite:</b>			
Robert E. McKee Inc -----	Box 107 Peach Springs, AZ 86434	Quarry and crushing plant	Mohave.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co., Construction Products Div. -----	4220 West Glenrosa Phoenix, AZ 85019	Plant -----	Maricopa.

<sup>1</sup>Also clays.<sup>2</sup>Also limestone.<sup>3</sup>Also gold.<sup>4</sup>Also lead.<sup>5</sup>Also silver.<sup>6</sup>Also molybdenum.<sup>7</sup>Also lime.



# The Mineral Industry of Arkansas

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

By James R. Boyle<sup>1</sup> and William V. Bush<sup>2</sup>

The value of Arkansas nonfuel mineral production in 1986 was \$263 million, a decrease of over \$7 million from that of 1985. Leading industrial minerals in terms of value were bromine, crushed stone, cement, and construction sand and gravel. The State ranked first nationally in output of bauxite, bromine, and special silica stone for abrasive products (oilstones and whetstones); second in crushed sandstone; and third in kaolin.

**Trends and Developments.**—The Arkansas economy remained relatively even as the unemployment rate stayed at about the

same level as that of 1985, the lowest level since 1980. Construction employment increased slightly during the year while mining employment dropped slightly, substantially as a result of a depressed State oil and gas extractive industry.

Arkansas River commerce in 1986 increased about 25% over that of 1985. Construction sand and gravel was the main commodity with over 2 million short tons being shipped. Crushed rock shipments also were up over those of 1985. Other minerals handled included alumina, bauxite, and vanadium slag.

Table 1.—Nonfuel mineral production in Arkansas<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons..	1,019	\$7,838	1,052	\$10,769	<sup>2</sup> 974	<sup>2</sup> \$8,998
Gem stones -----	NA	<sup>e</sup> 200	NA	<sup>e</sup> 200	NA	522
Sand and gravel:						
Construction --- thousand short tons..	8,334	23,786	<sup>e</sup> 8,500	<sup>e</sup> 24,400	8,571	26,999
Industrial ----- do.-----	459	6,207	412	5,414	400	3,975
Stone:						
Crushed ----- db.-----	<sup>e</sup> 15,200	<sup>e</sup> 59,800	14,815	60,874	<sup>e</sup> 15,500	<sup>e</sup> 58,500
Dimension ----- do.-----	W	W	5	305	<sup>e</sup> 5	<sup>e</sup> 305
Combined value of abrasives, <sup>3</sup> bauxite, bromine, cement, clays (fire clay, 1986), gypsum, lime, talc, tripoli (1984, 1986), vanadium (1984-85), and value indicated by symbol W	XX	<sup>r</sup> 175,019	XX	<sup>r</sup> 168,290	XX	163,708
Total -----	XX	<sup>r</sup> 272,850	XX	<sup>r</sup> 270,252	XX	263,007

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fire clay; value included with "Combined value" figure.

<sup>3</sup>Grindstones, pulpestones, and sharpening stones; excludes mill liners and grinding pebbles.



Table 2.—Nonfuel minerals produced in Arkansas in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Baxter	Stone (crushed).
Benton	Do.
Boone	Do.
Calhoun	Sand and gravel (industrial).
Carroll	Stone (crushed).
Clark	Stone (crushed), clays.
Cleburne	Stone (crushed).
Columbia	Bromine.
Craighead	Clays.
Crawford	Stone (crushed), sand and gravel (industrial).
Crittenden	Clays.
Faulkner	Stone (crushed).
Fulton	Do.
Garland	Stone (crushed), millstones.
Grant	Sand and gravel (industrial).
Hempstead	Sand and gravel (industrial), clays.
Hot Spring	Stone (crushed), clays, millstones.
Howard	Cement, gypsum, stone (crushed).
Independence	Stone (crushed), lime, stone (dimension).
Izard	Sand and gravel (industrial), stone (crushed).
Johnson	Clays.
Lawrence	Stone (crushed).
Little River	Cement, stone (crushed).
Logan	Stone (crushed), stone (dimension).
Marion	Stone (crushed).
Miller	Sand and gravel (industrial), clays.
Montgomery	Stone (crushed), clays.
Ouachita	Clays.
Perry	Stone (crushed).
Pike	Gypsum.
Pope	Stone (crushed).
Pulaski	Stone (crushed), clays.
Randolph	Stone (crushed).
Saline	Bauxite, stone (crushed), talc.
Sebastian	Stone (crushed), clays.
Sevier	Stone (crushed).
Union	Bromine.
Washington	Stone (crushed).
White	Do.
Undistributed <sup>2</sup>	Sand and gravel (construction), vanadium, gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Arkansas business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	2,347	2,360	2,372
Total civilian labor force	do.	1,041	1,052	1,073
Unemployment	percent	8.9	8.7	8.7
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup>	thousands	5.6	5.5	4.4
Nonmetallic minerals except fuels	do.	1.2	1.3	1.3
Coal mining	do.	.1	W	.1
Oil and gas extraction	do.	4.1	3.9	2.8
Manufacturing total	do.	213.0	209.6	212.1
Primary metal industries	do.	7.9	7.7	7.0
Stone, clay, and glass products	do.	4.9	4.8	4.7
Chemicals and allied products	do.	6.0	5.8	5.4
Petroleum and coal products	do.	1.2	1.0	1.0
Construction	do.	33.7	35.3	36.0
Transportation and public utilities	do.	45.4	47.2	48.3
Wholesale and retail trade	do.	172.9	180.7	184.4
Finance, insurance, real estate	do.	35.6	36.5	37.4
Services	do.	134.5	139.3	146.2
Government and government enterprises	do.	139.5	143.0	145.2
Total	do.	780.2	797.1	<sup>2</sup> 813.9
<b>Personal income:</b>				
Total	millions	\$23,361	\$24,903	26,268
Per capita		\$9,955	\$10,553	\$11,073
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		40.5	40.2	40.4
Total average hourly earnings, production workers		\$7.3	\$7.6	\$7.8

See footnotes at end of table.

Table 3.—Indicators of Arkansas business activity —Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Earnings by industry:<sup>3</sup></b>			
Farm income ----- millions...	\$1,072	\$1,082	\$1,092
Nonfarm ----- do.....	\$15,279	\$16,213	\$17,222
Mining total ----- do.....	\$167	\$181	\$142
Nonmetallic minerals except fuels ----- do.....	\$27	\$28	\$20
Coal mining ----- do.....	\$2	\$1	\$2
Oil and gas extraction ----- do.....	\$132	\$142	\$114
Manufacturing total ----- do.....	\$4,097	\$4,166	\$4,382
Primary metal industries ----- do.....	\$210	\$204	\$186
Stone, clay, and glass products ----- do.....	\$104	\$106	\$107
Chemicals and allied products ----- do.....	\$174	\$170	\$165
Petroleum and coal products ----- do.....	\$41	\$38	\$36
Construction ----- do.....	\$982	\$1,066	\$1,171
Transportation and public utilities ----- do.....	\$1,360	\$1,462	\$1,499
Wholesale and retail trade ----- do.....	\$2,613	\$2,766	\$2,887
Finance, insurance, real estate ----- do.....	\$740	\$819	\$928
Services ----- do.....	\$2,707	\$2,982	\$3,234
Government and government enterprises ----- do.....	\$2,510	\$2,725	\$2,884
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> -----	9,802	9,935	8,986
Value of nonresidential construction <sup>4</sup> ----- millions...	\$399.4	\$415.8	\$364.1
Value of State road contract awards <sup>5</sup> ----- do.....	\$169.6	\$160.0	\$167.0
Shipments of portland and masonry cement to and within the State thousand short tons... -----	761	818	851
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions...	\$272.9	\$270.3	\$263.0
Value per capita ----- do.....	\$116	\$115	\$111

<sup>p</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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 Arkansas Legislature meets biennially and did not convene in 1986. Several items of interest were under investigation and could result in recommendations to the 1987 session of the general assembly. These included a comprehensive study on mineral taxation and the possibility of commercial diamond mining at the Crater of Diamonds Park in Pike County.

The Arkansas Geological Commission continued its programs focusing on development and use of the State's mineral, water, and energy resources. Projects included a mapping program in the Ouachita Mountains, with a compilation of oil and gas test wells and development of resource data for lignite and other minerals in the State. Drilling activity expanded the lignite data base with stratigraphic test holes; lignite resources have been identified in southern

and northern Arkansas.

The Arkansas Department of Revenue received \$12.7 million in severance taxes in 1986, down from \$21.4 million in 1985. Severance taxes were received from the following industries: oil (\$11.5 million), natural gas (\$432,000), brine (\$415,000), construction sand and gravel (\$314,000), coal (\$5,200), and miscellaneous minerals including bauxite, diamonds, fuller's earth, stone (dimension), and sulfur (\$13,000).

The Arkansas Department of Labor, in its annual report, stated that 289 nonfuel mines operated in the State and produced a total of 20.3 million short tons of minerals compared with 21.3 million tons in 1985. Additionally, 11 coal mines in Franklin, Johnson, and Sebastian Counties produced slightly over 100,000 short tons of coal during the year.



## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

Industrial minerals were the major portion of the value of nonfuel mineral values in 1986.

**Abrasives (Natural).**—Arkansas ranked first nationally in output of special silica stone abrasives, producing over three-fourths of the total quantity sold in the Nation. Finished stone production accounted for 63% of the total quantity of special stone products sold or used. Novaculite, a dense, hard, fine-grained chert of nearly pure silica, was mined in Garland County by four companies and in Hot Spring County by one company. Output at all operations was relatively small, with a high percentage of waste material. Six companies finished small quantities of stone mined by others.

**Bromine.**—Arkansas remained the Nation's largest producer of bromine. Production increased about 7% over that of 1985, while value increased nearly 29%. Bromine occurred in brine in Columbia and Union Counties in the south-central part of the State. Two companies, Dow Chemical U.S.A. and Ethyl Corp., operated in Columbia County, while two others, Arkansas Chemicals Inc. and Great Lakes Chemical Corp., operated in Union County. Arkansas reportedly had 85% of the Nation's capacity to produce bromine chemicals. In addition to increased competition from imports and limited markets, the industry continued to face mounting environmental concerns about deep-well injections of waste materials.

Arkansas Chemicals reopened its El Dorado plant early in the year. The decision to reopen was based on contractual obligations.

Ethyl reached an agreement with The Dow Chemical Co. to purchase certain assets of Dow's bromine chemical business for about \$50 million. Included in the purchase was Dow's bromine chemicals plant in Magnolia, except for a clear fluids plant, as well as its brine field leases in Arkansas, along with distribution equipment and certain patents. Ethyl announced plans to build a plant to produce brominated flame-retardant products at its chemical complex in Magnolia. The \$10 million venture was scheduled for completion early in 1987.

Great Lakes Chemical announced an agreement in principle to acquire the outstanding stock of Pentech Corp. and its

wholly owned subsidiary, QO Chemicals Inc. QO is the world's largest producer and marketer of furfural-based specialty chemicals. Terms of the purchase included a \$110 million payment plus future considerations, depending upon performance.

**Cement.**—Portland cement shipments and value decreased from that of 1985; masonry shipments and value remained at the same level. Two companies, Ideal Cement Co. and Arkansas Cement Corp., produced portland and masonry cements at plants in Saratoga and Foreman, respectively. The plants, with a total of five kilns, used the wet process. Major end uses for portland cement were ready-mixed concrete, concrete products, building materials, and highway construction. Raw materials used in the manufacture of cement included chalk, gypsum, iron ore, limestone, and sand. The Aluminum Co. of America (Alcoa) plant at Bauxite remained one of three plants nationally that produced aluminous cement, a nonportland hydraulic cement.

Marketing area for cement was limited primarily to contiguous States. Imported cement, shipped up the Mississippi River into the Memphis, TN, area, intensified competition throughout the region.

**Clays.**—The clay industry in Arkansas produced common clay, fire clay, and kaolin, with total output decreasing from that of 1985. Arkansas ranked third in output of kaolin. Production of common clay decreased while that of kaolin increased. Common clay was mined by 7 companies at 14 pits in 10 counties; leading counties were Crittenden, Hot Spring, and Montgomery. Major uses were in brick and lightweight aggregate. Kaolin was mined by three companies at four pits in Pulaski County; output included both unprocessed and calcined kaolin. Fire clay was mined by one company in Pulaski County.

**Gem Stones.**—Park authorities at the Crater of Diamonds Park in Pike County reported that in 1986 about 75,000 visitors had recovered 930 diamonds, compared with 699 diamonds in 1985. Total weight amounted to 154.2 carats; the largest diamond recovered weighed 7.95 carats. Of the diamonds recovered, 23 weighed over 1 carat. During the year, a milestone was reached when the 10,000th diamond was found since the park opened in 1972.

The Arkansas State Parks Committee recommended that a study of a commercial

mining operation be conducted to determine if a mining operation could be set up that would be compatible with the tourist activities in the park. No further action was taken during the year.

**Graphite (Synthetic).**—Arkansas ranked sixth nationally in the production of synthetic graphite. Production and value of synthetic graphite decreased 31% and 15%, respectively, from that of 1985. Great Lakes Carbon Corp. manufactured graphite at its plant in Ozark while Superior Graphite Co. produced electrodes at Russellville. The electrodes produced were used in electric arc furnaces to melt scrap for production of steel.

**Gypsum.**—Production and value increased over that of 1985. Crude gypsum was produced by Weyerhaeuser Co. in Howard County and Harrison Gypsum Co. Inc. in Pike County. Weyerhaeuser's mine and plant ranked sixth and fourth, respectively, in output nationally. The plant had a reported capacity of 600 million square feet of wallboard per year. The company installed new burners in the plant and completed a 5-year program to computerize operations. Calcined gypsum was produced by Temple Eastex Inc., Crittenden County, and Weyerhaeuser, Howard County. Production increased while value decreased.

**Lime.**—Arkansas produced both quicklime and hydrated lime during 1986; output and value of both decreased from that of 1985 and remained at a relatively low level. Quicklime and hydrated lime were produced by Arkansas Lime Co., Independence County. Most of the quicklime produced was sold to Alcoa, which continued to operate at reduced levels of capacity.

**Nitrogen.**—Agrico Chemical Co., Blytheville, produced anhydrous ammonia in 1986.

The facility had an annual rated capacity of 407,000 short tons.

**Perlite (Expanded).**—Strong-Lite Products Corp. expanded perlite at its plant in Pine Bluff; raw material was shipped in from out of State. Expanded perlite was used in concrete aggregate and horticultural applications.

**Quartz.**—Various grades of natural quartz were surface mined and processed by Coleman Crystal Inc. and by Geomex Mine Services Inc.; output increased. Coleman was the only domestic producer of lascas. Lascas is the silicon dioxide feedstock material used for production of cultured quartz, fused quartz, and other electronic uses.

**Sand and Gravel.**—Arkansas produced both construction and industrial sand and gravel in 1986. Production was from 57 companies producing from 71 pits in 38 counties. Total output increased slightly over that of 1985, but was still below the record-high years of the 1970's.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel remained one of the leading commodities in value among the nonfuel minerals in Arkansas. The increase in 1986 was basically due to increased construction activities. Most operations were relatively small, with no individual pit producing as much as 1 million short tons. Construction sand and gravel was produced at 63 operations in 35 counties. Leading counties were Little River, Ouachita, and Pulaski.

Table 4.—Arkansas: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	3,687	\$12,750	\$3.46
Plaster and gunite sands -----	121	423	3.50
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	50	147	2.94
Asphaltic concrete aggregates and other bituminous mixtures -----	858	3,800	4.43
Road base and coverings -----	649	1,446	2.23
Fill -----	109	242	2.22
Other <sup>1</sup> -----	74	291	3.93
Other unspecified <sup>2</sup> -----	3,023	7,901	2.61
Total or average -----	8,571	<sup>3</sup> 26,999	3.15

<sup>1</sup>Includes roofing granules.

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Five companies produced industrial sand and gravel from five counties during 1986, with output and value decreasing from that of 1985. Producers were Arkhola Sand & Gravel Co., Gifford-Hill & Co. Inc., Ideal Cement, Malvern Minerals Co. Inc., and Silica Products Co. Inc. Major uses were in foundry molds, glassmaking, and blasting abrasives, with most shipped by railroad. No one operation produced more than 500,000 short tons.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains only estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Output of crushed stone increased for only the second time in the last 6 years while value decreased. Material mined included dolomite, granite (syenite), limestone, novaculite, sandstone, and slate. Arkansas was second in the Nation in output of crushed sandstone and was a major producer of crushed slate. Leading counties in output of crushed stone in 1985 were Pulaski, Lawrence, and Little River. Mid-State Construction Materials Inc. of Malvern started shipping crushed stone to northern Louisiana to replace limited resources of gravel in the area and to meet new road surface nonskid requirements in Louisiana.

**Dimension.**—Output of dimension stone remained at the same level as that of 1985. Dimension stone was quarried by three companies in Independence and Logan Counties.

**Sulfur (Recovered).**—Two companies recovered sulfur from their operations, with output remaining steady while unit prices increased. MKP Operating Co., Lafayette County, recovered sulfur as a byproduct of petroleum refining at its McKamie plant, while Ethyl recovered sulfur during bromine extraction at its Magnolia facility.

**Talc.**—The Milwhite Co. Inc. mined talc from its Congo Pit near Benton; the ore was processed at the Bryant mill. Production increased 46% from that of 1985. Major uses were as roofing materials and as an industrial filler.

**Tripoli.**—Malvern Minerals, Garland County, remained the State's only producer and processor of tripoli, with output used primarily as a filler.

**Vermiculite (Exfoliated).**—Strong-Lite, Pine Bluff, and W. R. Grace & Co., North Little Rock, exfoliated crude vermiculite from out of State. Exfoliated vermiculite

was used for texturing paint and in aggregate, insulation, agriculture, and fireproofing.

## METALS

The primary metals sector was a relatively small segment of the State's industrial base. The metals industry depended mainly on out-of-State raw materials, with some output from sources in Arkansas. Decreased activities in the aluminum industry have been offset by developments in the iron and steel sector.

**Aluminum.**—Arkansas was 1 of 17 States with primary aluminum production facilities; no production was reported in 1986. Reynolds Metals Co.'s aluminum facilities at Patterson and Jones Mill, closed in 1985, remained shut down for the entire year. Continuing high energy costs and low prices for aluminum were cited as reasons for the shutdown. During the year, Arkansas Power and Light Co. offered a 3-year contract to induce Reynolds to reopen both plants. Reynolds, after failure to reach an agreement with its union employees, announced the plants would not reopen.

**Bauxite.**—Arkansas continued to be the leading State in production of bauxite, even as output decreased. With the exception of 1984, output has decreased steadily since 1977. Output was from two operations in Saline County, Alcoa and American Cyanamid Co. Poroceel Corp., Little Rock, produced activated bauxite from purchased ore. Alcoa operated at relatively low levels of capacity in 1986, compounded by a mid-year, month-long strike. Mining operations were curtailed as alumina was received from Alcoa's Point Comfort, TX, alumina plant.

Norton-Alcoa Proppant Co., which started up its expanded facility in Fort Smith in July 1985, shut down early in 1986. The closure was the result of the drop in world oil prices and its negative impact on oil exploration. Also affected by the shutdown was Alcoa's bauxite operation, which was scheduled to supply 40,000 short tons of bauxite per year.

American Cyanamid continued to mine, process, and partially calcine bauxite for the production of aluminum sulfate, which was used in the paper industry and for water treatment.

**Gold.**—Developments in the State were limited to preliminary exploration by individuals and various companies. Several thousand acres were leased in the western counties, which included primarily Mont-

**gomery and Polk.**

**Iron and Steel.**—Quanex Corp. operated its 280,000-short-ton-per-year specialty alloy bar plant at Fort Smith during the year. Quanex produced seam-free carbon and alloy steel bars for the forging industry. Razorback Steel Corp. also operated a mini-mill at Newport. The electric arc furnace produced bars and small structural pieces. Commercial Metals Co. began construction of its mill in Magnolia; completion was scheduled for early 1987. Industrial revenue bonds were used to assist in financing the project. The 60,000-short-ton-year mill will reroil rail into posts and other specialty products. Included in the mill were a rail splitter, reheat furnace, rolling mill, and cooling bed.

Omega Tube & Conduit Corp., a subsidiary of Sumitomo Metal Industries Ltd., started construction of a high-frequency electric resistance pipe welding line to produce 2,000 short tons of alloy steel per month. The facility at Little Rock will cost \$5 million and was scheduled to go on-stream late in 1987.

Nucor Corp., Charlotte, NC, and Yamato Kogyo Co. of Japan announced plans to

build a 600,000-short-ton-per-year electric-furnace mill in northeastern Arkansas along the Mississippi River. Planned start-up was scheduled for mid-1988. Scrap iron will be shipped from the Midwest, and the mill will roll flats, channels, and angles. The plant will also cast beam blanks that allows less rolling.

The 1985 Arkansas Directory of Manufacturers listed six gray iron foundries, three steel foundries, and eight secondary smelters in operation in the State.

**Vanadium.**—Strategic Minerals Corp., which bought the Arkansas vanadium facilities of Umetco Minerals Corp. early in 1986, brought the vanadium oxide mill back into operation late in the year. The Hot Springs mill operated at about one-half its capacity of 12 million pounds per year; the mine remained closed. Feedstock was vanadium-bearing residue from oil refineries. The mill produced vanadium pentoxide and vanadium trioxide, both used to make ferro-vanadium and vanadium-aluminum.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Geologist, Arkansas Geological Commission, Little Rock, AR.

**Table 5.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
Oilstones and whetstones:			
Hiram A. Smith Whetstone Co. Inc	1500 Sleepy Valley Rd. Hot Springs, AR 71901	Quarry -----	Garland.
Tripoli:			
Malvern Minerals Co. Inc -----	Box 1246 Hot Springs, AR 71901	Mine -----	Do.
<b>Bauxite:</b>			
Aluminum Co. of America <sup>1</sup> -----	1501 Alcoa Bldg. Pittsburgh, PA 15219	Mine and plant --	Saline.
American Cyanamid Co -----	Berdan Ave. Wayne, NJ 07470	----do-----	Do.
<b>Bromine:</b>			
Arkansas Chemicals Inc -----	Route 6, Box 98 El Dorado, AR 71730	Brine wells and plant.	Union.
Dow Chemical U.S.A. -----	2030 Dow Center Midland, MI 48640	----do-----	Columbia.
Ethyl Corp., Arkansas Div -----	Box 729 Magnolia, AR 71753	----do-----	Do.
Great Lakes Chemical Corp -----	Box 2200 West Lafayette, IN 47906	----do-----	Union.
<b>Cement:</b>			
Arkansas Cement Corp., a subsidiary of Ash Grove Cement Co. <sup>1</sup>	Box 25900 Overland Park, KS 66225	Plant -----	Little River.
Ideal Cement Co., a subsidiary of Ideal Basic Industries Inc. <sup>1</sup>	Box 8789 Denver, CO 80201	----do-----	Howard.
<b>Clays:</b>			
Acme Brick Co., a division of Justin Industries Inc.	Box 425 Fort Worth, TX 76101	Pits and plants --	Hot Spring and Sebastian.
Arkansas Lightweight Aggregate Corp --	El Dorado, AR 71730 -----	Pit and plant.---	Crittenden.
Eureka Brick & Tile Co -----	Box 379 Clarksville, AR 72830	Mine -----	Johnson.
A. P. Green Refractories Co., a subsidi- ary of USG Corp.	Box 6057 Little Rock, AR 72216	Pit and plant.---	Pulaski.
<b>Gypsum:</b>			
Harrison Gypsum Co. Inc -----	Box 336 Lindsay, OK 73052	Mine -----	Pike.
Weyerhaeuser Co., Dierks Div -----	Route 4, Box 78 Nashville, AR 71852	Mine and plant --	Howard.

See footnotes at end of table.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime:			
Arkansas Lime Co., a subsidiary of Rangaire Corp. <sup>1</sup>	Box 2356 Batesville, AR 72501	Quarry and plant	Independence.
Perlite (expanded):			
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	Plant	Jefferson.
Sand and gravel:			
Construction:			
Jeffrey Sand Co	Box 998 Fort Smith, AR 72901	Pits	Faulkner, Pulaski, Sebastian.
St. Francis Materials Co., a division of Ben M. Hogan Co. Inc.	Box 999 Forrest City, AR 72335	Pits and plants	Calhoun, Craighead, Poinsett, St. Francis.
Industrial:			
Gifford-Hill & Co. Inc. <sup>2</sup>	Box 6615 Shreveport, LA 71106	Pits	Miller.
Silica Products Co. Inc	Box 29 Guion, AR 72540	do	Izard.
Stone (1985):			
Granite:			
Freshour Construction Co. Inc	Drawer AF Cabot, AR 72023	Quarry	Pulaski.
McGeorge Contracting Co. Inc	Box 7008 Pine Bluff, AR 71611	Quarries	Do.
Minnesota Mining & Manufacturing Co.	3M Center, 223-4N-05 St. Paul, MN 55144	Quarry	Do.
Limestone:			
McClinton-Anchor Co., a subsidiary of Ashland Oil Inc.	Box 756 Fayetteville, AR 72701	Quarries	Benton, Madison, Washington.
Midwest Lime Co	Box 2608 Batesville, AR 72501	Quarry	Independence.
Sandstone:			
Arkhola Sand & Gravel Co., <sup>1</sup> a subsidiary of Ashland Oil Inc.	Box 1627 Fort Smith, AR 72901	Quarries	Crawford and Sebastian.
H M B Construction Co.	Box 5606 Texarkana, TX 75501	Quarry	Sevier.
Ben M. Hogan Co. Inc. <sup>1</sup>	Box 2860 Little Rock, AR 72203	Quarries	White.
M & M Rock Co. Inc.	Box 1190 Conway, AR 72032	do	Faulkner, Perry, White.
Slate:			
Bird & Son Inc	Drawer 151 Glenwood, AR 71943	Quarry	Montgomery.
Sulfur (recovered):			
Ethyl Corp., Arkansas Div	Box 729 Magnolia, AR 71753	Sulfur recovered in bromine extraction.	Columbia.
Phillips Petroleum Co	724 Adams Bldg. Bartlesville, OK 74004	Sulfur recovered as a byproduct of petroleum refining.	Lafayette.
Talc:			
The Milwhite Co. Inc.	Box 15038 Houston, TX 77020	Mine and plant	Saline.
Vanadium:			
Strategic Minerals Corp	Route 6, Box 943 Hot Springs, AR 71901	Mine and mill	Garland.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Pulaski.
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	do	Jefferson.

<sup>1</sup>Also produced limestone.<sup>2</sup>Also produced construction sand and gravel in Ouachita County.





# The Mineral Industry of California

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

By F. V. Carrillo,<sup>1</sup> J. F. Davis,<sup>2</sup> and J. L. Burnett<sup>3</sup>

California continued to be the leading producer of nonfuel minerals in the United States during 1986. Value rose to \$2.27 billion, or about a 7% increase from that reported in 1985. The increase in value was attributed to continued growth in the con-

struction industry and a generally improving economy in the State, enhanced by a significant increase in gold production. Most industrial mineral operations were functioning near capacity throughout the year.

Table 1.—Nonfuel mineral production in California<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Boron minerals --- thousand short tons ---	1,367	\$456,687	1,269	\$404,775	1,251	\$426,086
Cement (portland) ----- do. -----	8,715	520,026	9,462	601,506	9,490	578,502
Clays <sup>2</sup> ----- do. -----	2,100	23,868	2,203	26,600	2,449	33,289
Gem stones ----- do. -----	NA	<sup>e</sup> 500	NA	<sup>e</sup> 550	NA	418
Gold (recoverable content of ores, etc.)						
troy ounces ---	85,858	30,965	<sup>r</sup> 187,813	<sup>r</sup> 59,660	425,617	156,729
Gypsum ----- thousand short tons ---	1,382	12,443	1,332	12,201	1,378	10,777
Lime ----- do. -----	406	26,827	367	24,733	371	24,187
Pumice ----- do. -----	80	1,600	78	1,491	46	1,263
Sand and gravel:						
Construction ----- do. -----	102,420	360,427	<sup>e</sup> 112,800	<sup>e</sup> 430,000	128,407	498,456
Industrial ----- do. -----	2,281	39,176	2,255	37,434	2,364	44,813
Silver (recoverable content of ores, etc.)						
thousand troy ounces ---	W	W	115	709	155	849
Stone:						
Crushed ----- thousand short tons ---	<sup>e</sup> 38,600	<sup>e</sup> 158,000	41,199	174,395	<sup>e</sup> 38,500	<sup>e</sup> 159,300
Dimension ----- do. -----	<sup>r</sup> 23	<sup>r</sup> 1,658	23	2,449	<sup>e</sup> 23	<sup>e</sup> 2,582
Talc and pyrophyllite ----- do. -----	74	1,642	100	2,493	64	1,528
Combined value of asbestos, calcium chloride (natural), cement (masonry), clays (ball clay, 1986, and fire clay, 1984-85), copper, diatomite, feldspar, iron ore (usable), lead (1984), magnesium compounds, molybdenum, peat, perlite, potassium salts, rare-earth metal concentrates, salt, sodium carbonate (natural), sodium sulfate (natural), tungsten ore and concentrate, wolastonite (1984, 1986), and value indicated by symbol W	XX	360,085	XX	<sup>r</sup> 333,014	XX	330,638
Total -----	XX	<sup>r</sup> 1,993,904	XX	<sup>r</sup> 2,112,010	XX	2,269,417

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes ball clay and fire clay; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in California in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Alameda	Salt, stone (crushed), clays.
Amador	Sand (industrial), clays, stone (crushed).
Calaveras	Asbestos, talc, stone (crushed).
Colusa	Stone (crushed).
Contra Costa	Stone (crushed), sand (industrial), clays.
Del Norte	Stone (crushed), gold.
El Dorado	Stone (crushed).
Fresno	Gold, stone (dimension), clays, stone (crushed), silver.
Glenn	Lime, stone (crushed).
Humboldt	Stone (crushed).
Imperial	Gypsum, gold, stone (crushed), lime, silver.
Inyo	Boron minerals, tungsten, stone (crushed), talc, perlite, molybdenum, clays, pumice, copper, stone (dimension), gold.
Kern	Boron minerals, cement, clays, stone (crushed), gypsum, stone (dimension).
Kings	Gypsum.
Lake	Stone (crushed).
Lassen	Diatomite, stone (crushed).
Los Angeles	Stone (crushed), clays, stone (dimension).
Madera	Tungsten, stone (dimension), pumice, stone (crushed).
Marin	Stone (crushed), clays.
Mariposa	Stone (dimension), stone (crushed).
Modoc	Stone (crushed), peat.
Mono	Pumice, stone (crushed), clays, gold, silver, talc.
Monterey	Magnesium compounds, stone (crushed), sand (industrial).
Napa	Gold, stone (crushed), salt, silver, stone (dimension).
Nevada	Clays, stone (crushed).
Orange	Clays, sand (industrial), feldspar, stone (crushed).
Placer	Clays, stone (dimension), stone (crushed).
Plumas	Gold, stone (dimension), stone (crushed).
Riverside	Cement, stone (crushed), iron ore, clays, gypsum, sand (industrial), stone (dimension).
Sacramento	Clays.
San Benito	Stone (crushed), asbestos, clays.
San Bernardino	Cement, sodium carbonate, boron minerals, stone (crushed), rare-earth minerals, sodium sulfate, potassium salts, calcium chloride, salt, clays, gold, iron ore, talc, cement, feldspar, silver, gypsum.
San Diego	Sand (industrial), stone (crushed), stone (dimension), feldspar, salt.
San Joaquin	Gold, silver.
San Luis Obispo	Stone (crushed), gypsum, stone (dimension).
San Mateo	Magnesium compounds, salt, stone (crushed).
Santa Barbara	Diatomite, lime, stone (dimension), stone (crushed).
Santa Clara	Cement, stone (crushed).
Santa Cruz	Cement, stone (crushed), sand (industrial), clays, peat.
Shasta	Cement, stone (crushed), clays.
Sierra	Gold.
Siskiyou	Gold, silver, stone (crushed), pumice.
Solano	Stone (crushed).
Sonoma	Do.
Stanislaus	Gold, silver.
Sutter	Clays.
Tehama	Stone (crushed).
Trinity	Do.
Tulare	Do.
Tuolumne	Do.
Ventura	Sand (industrial), clays, stone (crushed), gypsum.
Yuba	Clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of California business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population	25,780	26,358	26,981
Total civilian labor force	12,619	12,995	13,365
Unemployment	7.8	7.2	6.7
<b>Employment (nonagricultural):</b>			
Mining total	50.0	49.9	42.5
Metal mining	1.6	1.7	2.0
Nonmetallic minerals except fuels	6.7	7.1	6.7
Oil and gas extraction <sup>1</sup>	41.7	40.0	32.7
Manufacturing total	2,065.5	2,076.1	2,063.9
Primary metal industries	42.6	41.6	40.9
Stone, clay, and glass products	51.6	50.8	52.1
Chemicals and allied products	64.1	63.7	63.7
Petroleum and coal products	30.0	28.8	27.4
Construction	445.2	496.2	521.5
Transportation and public utilities	554.6	568.7	576.1
Wholesale and retail trade	2,507.4	2,626.1	2,712.6
Finance, insurance, real estate	694.2	724.5	765.7
Services	2,509.5	2,644.8	2,756.3
Government and government enterprises	1,747.4	1,792.8	1,832.9
Total	10,573.8	10,979.1	<sup>2</sup> 11,271.6
<b>Personal income:</b>			
Total	\$389,190	\$422,676	\$456,098
Per capita	\$15,097	\$16,036	\$16,904
<b>Hours and earnings:</b>			
Total average weekly hours, production workers	40.3	40.2	40.3
Mining (nonmetallic minerals, except fuels)	43.0	42.0	40.7
Total average hourly earnings, production workers	\$9.8	\$10.1	\$10.4
Mining (nonmetallic minerals, except fuels)	\$14.4	\$15.1	\$15.2
<b>Earnings by industry:<sup>3</sup></b>			
Farm income	\$5,358	\$5,637	\$6,323
Nonfarm	\$280,672	\$307,211	\$331,632
Mining total	\$2,459	\$2,718	\$2,455
Metal mining	\$58	\$88	\$120
Nonmetallic minerals except fuels	\$250	\$282	\$172
Oil and gas extraction	\$2,147	\$2,362	\$2,158
Manufacturing total	\$58,291	\$62,230	\$64,700
Primary metal industries	\$1,444	\$1,306	\$1,333
Stone, clay, and glass products	\$1,450	\$1,486	\$1,621
Chemicals and allied products	\$1,965	\$2,088	\$2,153
Petroleum and coal products	\$1,541	\$1,650	\$1,628
Construction	\$18,266	\$20,110	\$22,410
Transportation and public utilities	\$19,023	\$20,086	\$21,201
Wholesale and retail trade	\$46,866	\$51,177	\$55,087
Finance, insurance, real estate	\$18,529	\$21,089	\$24,976
Services	\$70,565	\$78,729	\$86,345
Government and government enterprises	\$44,350	\$48,652	\$51,803
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup>	225,501	271,396	314,641
Value of nonresidential construction <sup>4</sup>	\$10,961.4	\$12,183.8	\$11,814.3
Value of State road contract awards <sup>5</sup>	\$555.0	\$965.0	\$2,857.5
Shipments of portland and masonry cement to and within the State	9,316	10,130	11,282
<b>Nonfuel mineral production value:</b>			
Total crude mineral value	\$1,993.9	\$2,112.0	\$2,269.4
Value per capita	\$77	\$79	\$84

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data do not add to total shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

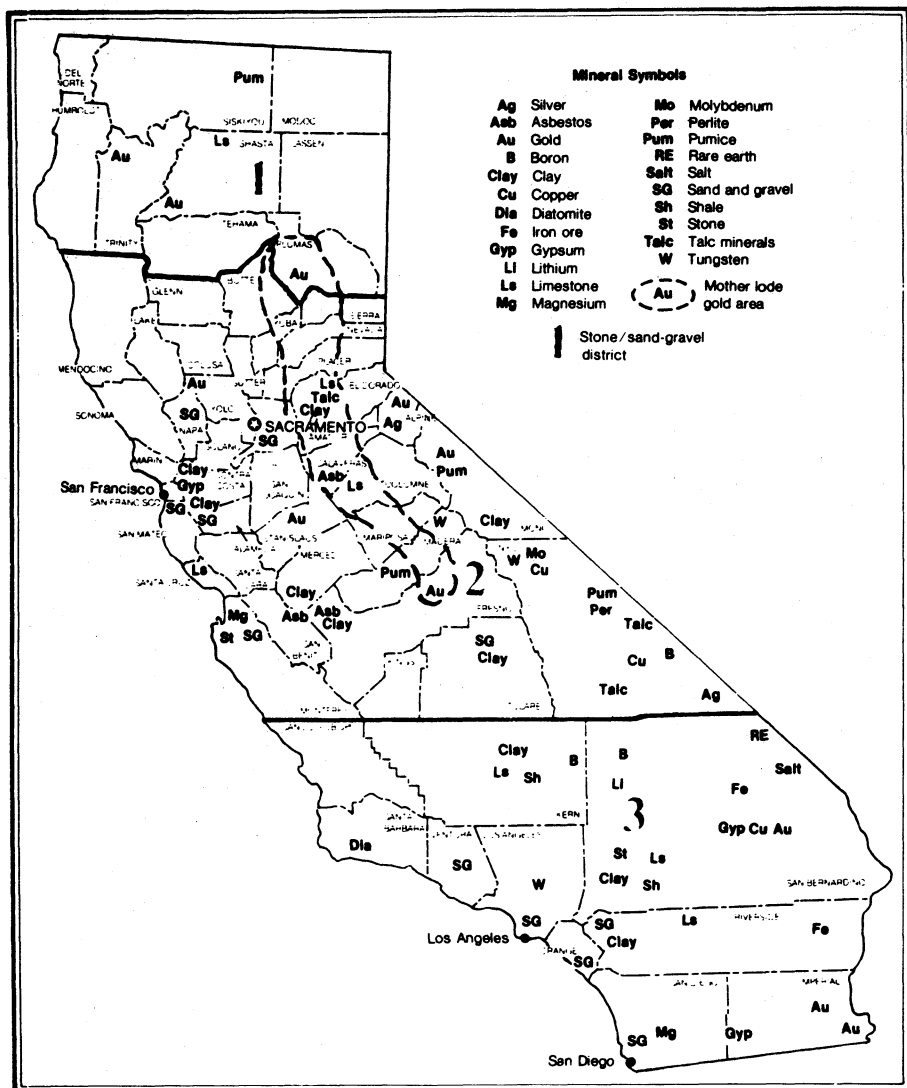


Figure 1.—Principal mineral-producing localities in California.

California ranked first nationally in the production of asbestos, portland cement, diatomite, calcined gypsum, rare-earth concentrates, construction sand and gravel, sodium compounds, and tungsten, and was the sole producer of boron minerals. It ranked second in the production of natural calcium chloride, gold, magnesium compounds, and sodium carbonate.

**Trends and Developments.**—Industrial

minerals accounted for the bulk of California's nonfuel mineral production, comprising more than 95% of the State's mineral production value. In 1986, 33 mineral commodities, including 7 metallic minerals, were produced in California. A rising trend continued in mineral production and value from a 1982 low, reflecting the continuing expansion of the State's economy.

The State's gold production more than doubled from that of 1985 to 425,617 troy ounces, elevating California to the second highest gold-producing State in the Nation. The value of gold produced was \$156.7 million, up \$97 million from that of 1985, as a number of reopened mines in the Mother Lode area and the California desert region began production from open pit projects in low-grade disseminated ore.

Several cement companies in the State were acquired by foreign firms during the year. Calaveras Cement Co., Gifford-Hill & Co. Inc., and Genstar Cement Ltd. were among those that became affiliated with Belgian, English, and Canadian interests through mergers, takeovers, or stock purchases.

Offshore exploration for metallic sulfides was concentrated off northern California along the Gorda Ridge.

**Legislation and Government Programs.**—The U.S. Supreme Court reviewed a decision of the ninth U.S. Circuit Court of Appeals that the Federal Government was not the sole regulator of mining operations on Federal lands in the Granite Rock Co.'s Pico Blanco deposit in the Los Padres National Forest. State authorities of the California Coastal Commission contended that Granite Rock must also apply for a State permit to mine on Federal lands within

their jurisdiction.

The California State Mining and Geology Board with the Department of Conservation, cosponsored five Mined Land Reclamation workshops during the year to establish policy and priorities for the Surface Mining And Reclamation Act (SMARA) program. Thirty-two maps of new and revised special studies zones were reviewed and issued pursuant to the provisions of the Alquist-Priolo Special Studies Zones Act. Five new SMARA classification reports were reviewed and transmitted to affected lead agencies. The board completed designation of aggregate resources in seven metropolitan areas in the State, which include the Claremont-Upland, San Bernardino, Saugus-Newhall, Palmdale, North San Francisco Bay, South San Francisco Bay, and Monterey Bay production-consumption regions.

The California office of the U.S. Bureau of Land Management (BLM) announced that 15,730 new mining claims were staked on public lands in California in 1986, bringing the total number of active claims on public lands in the State to 136,000. Miners filed 188 plans of operation with the BLM during 1986, compared with 167 plans in 1985. Mineral exploration and mining operations were conducted on 51 Federal leases covering 45,000 acres.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Asbestos.**—California continued to be the Nation's leading producer of asbestos. Production, which was reported from two mines, Calaveras Natural Resources Inc.'s Copperopolis Mine in Calaveras County and KCAC Inc.'s Joe Asbestos Mine in San Benito County, was about 10% lower than that of 1985.

**Boron Minerals.**—Sales of boron minerals declined slightly from the 1985 figure to 1,251,000 short tons, although value rose to \$426 million making boron California's third highest valued mineral in 1986.

California was the only domestic source of boron minerals, principally in the form of sodium borate. United States Borax & Chemical Corp., a subsidiary of RTZ Corp. of London, England, United Kingdom, operated a mine and processing plant in Kern County that continued to supply the major portion of the State's production. Kerr-McGee Chemical Corp. operated its Trona

and Westend plants in San Bernardino County to produce a variety of borate products.

American Borate Co., a wholly owned subsidiary of Owens-Corning Fiberglas Corp., reported production of colemanite and ulexite-probertite from its Billie Mine in Death Valley National Monument. The processed colemanite was trucked to Dunn for shipment by rail to manufacturers of textile-grade glass tubes. The mine ceased production in April, and plant processing was halted June 1. American Borate planned to continue to operate the Dunn facility as a custom grinding plant.

Mountain States Mineral Enterprises began solution mining tests using solar ponds at its Fort Cady project near Barstow. Reserves delineated by core drilling were approximately 8 million short tons of boron oxide from a deposit containing 147 million tons of ore averaging 12% colemanite. A process was patented for the cyclic solution mining of these borate ores using hydrochloric acid to produce boric acid and calci-

um chloride, and solar energy to concentrate the leach solution.

**Calcium Chloride.**—Natural calcium chloride production was reported from three operations in San Bernardino County: the State's largest salt producer, Leslie Salt Co., a subsidiary of Cargill Inc., at its Amboy plant; National Chloride Co. of America at its Bristol Lake plant; and Hill Bros. Chemical Co. at its Cadiz plant. Total output in California decreased 17% from that of 1985.

**Cement.**—Nearly all of the reported cement production in the State was finished portland cement; a small amount of masonry cement was also sold. Production of finished portland cement was 6% higher than that of 1985, pushing California to a number one ranking among the producing States. A value of more than \$578 million made portland cement California's most valuable nonfuel mineral commodity. Eleven plants continued to report cement production in the State, eight of which were in southern California.

CalMat Co., Kaiser Cement Corp., and Southwestern Portland Cement Co. were the largest producers of finished portland cement. CalMat, at its Colton plant in San Bernardino County, and Lone Star Industries Inc., at its Davenport plant in Santa Clara County, also reported small amounts of masonry cement production.

Calaveras Cement merged with C-B-R, a Belgian corporate complex, in September, but operations at the Mountain Gate plant remained the same after the merger. C-B-R also bought the inactive Genstar plant in San Andreas. The merger ended Calaveras association with San Francisco-based Genstar Cement, which agreed in April to a takeover by IMASCO Ltd., a Canadian tobacco company. Gifford-Hill of Dallas, TX, with plants in Oro Grande and Crestmore, was acquired by C. H. Beazer PLC of the United Kingdom. Blue Circle Industries PLC opened a deepwater terminal near San Francisco to develop surrounding markets.

**Clays.**—Production of 2.4 million short tons of clay and shale valued at more than \$33.3 million was reported from 31 companies in 23 counties throughout the State, ranking California fifth among the 44 reporting States in total clay production. Among specialty clays, it was third in the production of kaolin, fourth in bentonite, and fifth in common clay.

California bentonite producers continued to cancel or defer planned enlargements and modernizations. Most plants continued

sporadic operations at lower production levels as the industry continued to be affected by less oil and gas drilling and the downturn in demand by the steel and foundry industries.

Output of common clay and shale in California rose to 2,228,871 short tons. Clay and shale were used in the manufacture of structural clay products, such as brick, drain tile, portland cement, and expanded lightweight aggregates.

**Diatomite.**—California continued as the leading U.S. diatomite-producing State, with production reported in Santa Barbara, Shasta, and Sutter Counties. The major producer was Manville Products Corp. from operations near Lompoc in Santa Barbara County. Grecco Inc., the second largest producer in the State, supplemented its Lompoc plant production with diatomite from its new Burney plant in Shasta County.

**Feldspar.**—California ranked fourth nationally in the production of feldspar and feldspar-silica mixtures, which remained similar to that of 1985 in both quantity and value. The production of feldspar-silica mixtures was reported from Calspar Inc.'s San Bernardino County plant, from Crystal Silica Co.'s Oceanside plant in San Diego County, and California Silica Products Co.'s Mission Viejo plant in Orange County.

Steelhead Resources Ltd., operators of a feldspar processing plant at Santa Fe Springs, began an expansion of its feldspar mining operations in the Ord Mountains near Barstow.

**Graphite (Synthetic).**—California ranked 10th in the Nation in the production of synthetic graphite. Great Lakes Carbon Corp.'s plant in Kern County was closed. Three plants in Los Angeles County and one plant in Sacramento County produced synthetic graphite for cloth and fibers.

**Gypsum.**—California ranked first nationally in the production of calcined gypsum, with total output of 1,695,050 short tons, although it ranked only fifth among the States in the production of crude gypsum during 1986, with 1,378,000 short tons. USG Corp.'s Plaster City Mine in Imperial County was the country's leading individual mine, and its Plaster City plant was the second largest plant in the country. General Chemical Corp. and J. R. Simplot Co. both produced byproduct gypsum for agricultural use and some for gypsum wallboard manufacturing.

Crude gypsum output was reported from seven mines in Imperial, Kern, Kings, Riverside, San Bernardino, San Luis Obispo, and Ventura Counties. Calcined gypsum

was produced in six plants in Alameda, Contra Costa, Imperial, and Los Angeles Counties. Byproduct gypsum was produced in Contra Costa, Fresno, and San Joaquin Counties.

Fannin-Superior Gypsum Co.'s Lost Hill Mine in Kern County remained closed during the year, but shipped gypsum from its stockpile. Genstar Corp., a major producer of gypsum in California, was purchased by IMASCO, a Canadian firm, which then agreed to sell Genstar's entire gypsum business, Genstar Gypsum Products Co., to another Canadian firm, Domtar Inc. The proposed \$241 million sale was under review by the U.S. Department of Justice at year-end.

**Lime.**—Lime output increased slightly to 371,000 short tons, ranking California 12th among the 36 States (and Puerto Rico) among lime production. The National Refractories & Minerals Corp.'s quicklime plant in Monterey County was the State's largest producer. Genstar Cement & Lime reported production from Contra Costa and Los Angeles Counties plants. Holly Sugar Co., with three plants in Glenn, Imperial, and San Joaquin Counties, and Kerr-McGee, with its Westend plant in San Bernardino County, were also important producers. Additional quicklime production was reported in Santa Barbara, Tuolumne, and Yolo Counties.

**Magnesium Compounds.**—Production of magnesium compounds from seawater rose 54% from that of 1985, while value increased only 52%. National Refractories & Minerals produced magnesia and magnesium hydroxide from hydrated dolomitic lime and seawater at its Monterey County operation. Merck & Co. Inc. produced magnesium hydroxide, magnesium carbonate, and magnesium oxide from seawater at its San Mateo County plant near South San Francisco.

**Peat.**—Peat sales rose slightly. Radel Inc. in Modoc County and Hyponex Corp. in Santa Cruz County were the only producers.

**Perlite.**—Crude perlite was mined in Inyo County at American Perlite Co.'s Fish Springs Mine. Processed perlite production was reported from seven plants in Los Angeles, San Bernardino, and San Diego Counties.

Perlite Processing Co. began processing ore from Superior, AZ, at its Santa Fe Springs plant. Los Angeles County produced nearly 50% of the total expanded perlite in the State. International Permalite Co.'s plant in San Bernardino County was the State's largest producer of expanded perlite.

**Potash.**—Kerr-McGee produced muriate of potash (60%  $K_2O$ ) and sulfate of potash (50%  $K_2O$ ) from plants in San Bernardino County. Production and value declined slightly from that of 1985.

**Pumice.**—California remained the third largest producing State, despite a continuing slide in production to 46,000 short tons of pumice and pumicite (volcanic ash) sold in 1986, and in value to \$1,263,000. Siskiyou County was the leading producer of the five counties reporting pumice output. Inyo, Madera, Modoc, and Mono Counties production was used primarily in concrete aggregate, building, decorative blocks, and crop dusting.

**Salt.**—Salt was produced in five California counties, including Alameda, Napa, San Bernardino, San Diego, and San Mateo. Cargill's Leslie Salt was the largest producer with plants in Alameda, Napa, San Bernardino, and San Mateo Counties. Pacific Salt & Chemical Co. was another important San Bernardino County producer. Production remained near that of 1985.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

California's 1986 output of construction sand and gravel increased more than 25% in quantity and 38% in value from that reported in 1984, making California the leading sand and gravel producer among the States, and construction sand and gravel the State's second most valuable commodity.

A study by the U.S. Bureau of Mines of offshore construction sand and gravel deposits near seven major metropolitan areas within the U.S. Exclusive Economic Zone (EEZ) included two sites near Los Angeles and San Francisco. The Los Angeles site was found to have favorable economic conditions for offshore mining and was one of three sites selected for consideration as near-term lease offerings. The San Francisco site was not found favorable for consideration.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 5 presents end-use data for construction sand and gravel production in three districts depicted in figure 1.



**Table 4.—California: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	36,994	\$150,804	\$4.08
Plaster and gunitite sands -----	2,556	12,511	4.89
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	2,641	8,978	3.40
Asphaltic concrete aggregates and other bituminous mixtures -----	21,136	87,212	4.13
Road base and coverings <sup>1</sup> -----	22,270	81,077	3.64
Fill -----	8,197	20,857	2.54
Snow and ice control -----	2	12	6.00
Railroad ballast -----	609	2,625	4.31
Other -----	2,868	11,330	3.95
Other unspecified <sup>2</sup> -----	31,132	123,051	3.95
Total <sup>3</sup> or average -----	128,407	498,456	3.88

<sup>1</sup>Includes road and other stabilization (cement).<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>3</sup>Data may not add to totals shown because of independent rounding.**Table 5.—California: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand)	300	1,125	17,728	77,453	18,966	72,225
Plaster and gunitite sands -----	35	236	1,117	5,554	1,404	6,721
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	--	--	78	379	2,564	8,598
Asphaltic concrete aggregates and other bituminous mixtures -----	540	2,283	9,581	43,865	11,014	41,064
Road base and coverings <sup>1</sup> -----	953	2,616	11,357	42,167	9,959	36,295
Fill -----	193	542	3,455	9,384	4,549	10,981
Railroad ballast -----	76	276	504	2,255	29	95
Other <sup>2</sup> -----	27	133	2,302	8,996	541	2,213
Other unspecified <sup>3</sup> -----	538	1,713	5,342	18,447	25,252	102,891
Total <sup>4</sup> -----	2,664	8,924	51,464	208,499	74,279	281,033

<sup>1</sup>Includes road and other stabilization (cement).<sup>2</sup>Includes snow and ice control.<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Industrial sand production of 2,364,033 short tons was reported from 11 operations in 9 counties. California ranked third among the States in order of volume produced. Three companies each produced more than 200,000 tons. Industrial sand was used primarily in blasting, fiberglass manufacture, and glass containers.

U.S. Borax of Los Angeles, a subsidiary of The Rio Tinto Zinc Corp. PLC of the United Kingdom, purchased Ottawa Silica Co. of Ottawa, IL, acquiring not only the Nation's fourth largest U.S. producer of industrial sand but also its Crystal Silica plant near Oceanside. The newly formed U.S. Silica Co.

was California's third largest producer.

**Sodium Compounds.**—California led the Nation in sodium sulfate production during 1986 and was second in the production of sodium carbonate. All sodium sulfate production was from Kerr-McGee's Westend and Argus plants in San Bernardino County, where natural brines were pumped from Searles Lake. Kerr-McGee announced plans to consolidate its soda ash activities by terminating soda ash production at its Westend plant, making the Argus plant the only soda-ash-producing facility in the State and eliminating about 100,000 short tons of annual production.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Production was estimated to decrease slightly to 38,500 short tons, about 7% lower than that of 1985. Principal uses continued to be in cement manufacture, construction materials, road base and coverings, aggregates, rip rap, and jetty stone.

**Talc and Pyrophyllite.**—California ranked sixth among the nine producing States reporting talc and pyrophyllite production, with production down 36% from that of 1985.

Although several plants and mines remained idle during the year, crude talc was mined at nine locations in Calaveras, Inyo, Mono, and San Bernardino Counties. Processed talc production was reported from six plants in Calaveras, Inyo, Los Angeles, Sacramento, and San Bernardino Counties.

Pyrophyllite was mined at two locations in Mono County. The Victorite Mine in San Bernardino County was sold to Old Quaker Paint Co. of Santa Ana and used to warehouse paint.

**Vermiculite (Exfoliated).**—California ranked first among the 28 States that reported exfoliated vermiculite production. W. R. Grace & Co. was the sole producer from plants in Alameda and Orange Counties. Principal use was in fireproofing, with smaller amounts used in concrete and plaster aggregates and in horticulture.

**Wollastonite.**—Pfizer Inc. was the State's sole producer from an operation in Riverside County. Production, which resumed in 1986 after a hiatus in 1985, was less than that of 1984.

## METALS

**Copper.**—The only copper production reported in the State during 1986 was byproduct copper from tungsten ore processing at Strategic Minerals Corp.'s (Stratcor) Pine Creek tungsten mill in Inyo County.

**Gold.**—California became the second largest gold-producing State in the Nation; reported production more than doubled from that of 1985 to 425,617 troy ounces valued at \$156,729,000. The increase resulted from the reopening of several old mines in the Mother Lode and California desert regions and the opening of a new mine in Imperial County, Gold Fields Mining Corp.'s open pit Mesquite Mine.

Gold production was reported from 13 lode mines in the State and 5 placer operations in Del Norte, Nevada, Sierra, Siskiyou, and Yuba Counties.

Homestake Mining Co.'s McLaughlin Mine in Napa County was the State's largest gold mine, completing its first full year's production of 173,000 troy ounces of gold. The new Mesquite Mine, 35 miles east of Brawley in the southern California desert, was California's second largest gold producer in 1986. The first gold was poured at Gold Fields' plant near Glamis in Imperial County during test periods in February, with heap-leach operations beginning in March. Other significant producers were Chemgold Inc.'s Picacho Mine in Imperial County, the Brush Creek Mine near Downieville in Sierra County, Vanderbilt Gold Corp.'s Morningstar Mine in San Bernardino County, and Yuba-Placer Gold Co.'s placer gold operation in Yuba County.

Several reopened mines began producing gold during the year—the Carson Hill Mine in Calaveras County, the Goldstripe Mine in Plumas County, and Beaver Resources Kramer Hills Mine in Kern County. CoCa Mines began gold production at the Cactus Queen Mine in the Mojave Mining District of San Bernardino County. According to press releases, 10,800 troy ounces of gold were shipped during the last four months of 1986.

Exploration and development work was conducted at two mines in the western Cargo Muchacho Mountains, Imperial County, by the American Girl Mining Corp. Plans were announced to operate the American Girl Mine by underground methods and the adjacent Padre-Madre Mine as an open pit. Development work and heap leaching were started by Chemgold at the Yellow Aster Mine near Randsburg, Kern County. Sonora Mining Co. neared completion of its mill in Tuolumne County.

Bently Resources Ltd. reported exploration drilling on the Bagdad Chase gold property 50 miles east of Barstow in San Bernardino County. Exploration drilling was also reported at Viceroy Resource Corp.'s Castle Mountain open pit gold property in San Bernardino County. Asamera Minerals (U.S.) Inc. completed a drilling program at the Gaston Gold property in Nevada County. Core drilling encountered gold and silver values at the Blue Moon project of Westmin Resources and Colony Pacific Exploration in Tuolumne County.

Gold was also recovered as a byproduct from sand and gravel operations and from dredging operations. Placer Services Corp.'s Yuba 21 bucket-line dredge near Hammon-ton in Yuba County was the State's major dredge operation. Placer gold mining by individuals with small suction dredges was a popular recreational pursuit on many California rivers.

Mining operations, begun in 1982, were terminated at the Grey Eagle Mine of No-randa Grey Eagle Mines Inc., near Happy Camp in Siskiyou County. Exhaustion of the ore body was the reason for the closure.

**Iron Ore.**—Production of crude iron ore continued to decline in the State; output was less than half that reported in 1985.

**Iron and Steel.**—Kawasaki Steel Corp. of Japan and Rio Doce Ltd. of Brazil bought the remaining 50% interest in California Steel Industries Inc. to acquire full control of the Fontana steel plant. California Steel also purchased all the fixed assets of KPC Inc., a pipe and tube producer also in Fontana.

**Molybdenum.**—All of California's 1986 molybdenum production was byproduct from tungsten recovery at Stratcor's Pine Creek Mine in Inyo County.

**Rare-Earth Metal Concentrate.**—Rare-earth production continued to drop to its lowest level in 10 years in 1986, as demand decreased in certain markets, particularly catalysts. Molycorp Inc., a wholly owned subsidiary of Unocal Corp., was the sole producer from the Mountain Pass bastna-site mine in San Bernardino County. According to Unocal's annual report, despite declining sales, revenues from Molycorp's rare-earth products were the third highest in the company's history. Molycorp began marketing an extended line of neodymium products for use in neodymium-iron-boron permanent magnets.

The P. W. Gillibrand Co. began test production of a mixed heavy-minerals concentrate containing rare-earth-bearing apatite; however, additional separation was needed to produce salable rare-earth products.

**Silver.**—California ranked 11th among the States in the amount of silver production, an increase from the previous year to 155,176 troy ounces valued at \$849,000. Silver production was reported as byproduct from eight gold mines in Calaveras, Imperial, Kern, Mono, Napa, Siskiyou, and San Bernardino Counties. Principal producers were Homestake Mining's McLaughlin Mine in Napa County and Gold Fields' Mesquite Mine in Imperial County. A small amount of placer silver production was reported from gold dredging and gravel operations in Fresno, San Joaquin, and Stanislaus Counties.

**Tungsten Ore and Concentrate.**—Both quantity and value were slightly lower, but California still ranked first among the two States reporting tungsten production. By yearend, however, production had all but ceased with the permanent closure in December of the year's largest producer, Teledyne Tungsten's Strawberry Mine and mill in Madera County. Production was reported from two operations in Inyo and Kern Counties. Both operations were operated on a below-capacity, intermittent basis during the year. Curtis Tungsten Co. in Los Angeles County continued concentrating at its stockpile but did not sell stocks during the year. Stratcor, Danbury, CT, acquired the Pine Creek Mine and mill in Inyo County from Umeco Minerals Corp. in May.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Reno, NV.

<sup>2</sup>State geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.

<sup>3</sup>Geologist, California Department of Conservation, Division of Mines and Geology, Sacramento, CA.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asbestos:</b>			
Calaveras Natural Resources Inc ---	Box 127 Copperopolis, CA 95228	Surface mine and plant.	Calaveras.
KCAC Inc -----	Box K King City, CA 93930	-----do -----	San Benito.
<b>Boron minerals:</b>			
Kerr-McGee Chemical Corp. <sup>1</sup> -----	Kerr-McGee Center Oklahoma City, OK 73125	Evaporators and plant.	San Bernar- dino.
United States Borax & Chemical Corp.	Box 75128 Sanford Station Los Angeles, CA 90010	Surface mine and plant.	Kern.
<b>Calcium chloride:</b>			
Leslie Salt Co., <sup>2</sup> a subsidiary of Cargill Inc.	Box 5621 Minneapolis, MN 55440	Solar evaporators	San Bernar- dino.
National Chloride Co. of America <sup>2</sup> --	Box 604 Norwalk, CA 90650	-----do -----	Do.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
CalMat Co. <sup>3</sup> -----	3200 San Fernando Rd. Los Angeles, CA 90065	Plants -----	Various.
Kaiser Cement Corp -----	300 Lakeside Dr. Oakland, CA 94612	-----do-----	Do.
Southwestern Portland Cement Co. <sup>4</sup> -----	Box 937 Victorville, CA 92392	Plant -----	San Bernar- dino.
<b>Clays:</b>			
Excel Minerals Co -----	Box 878 111 South La Patera Lane Goleta, CA 93116	Pits -----	Kern.
Gifford-Hill & Co. Inc., Phoenix Cement Co. <sup>5</sup> -----	Box 47127 Dallas, TX 75241	-----do-----	Various.
Lightweight Processing Co -----	715 North Central Ave. Suite 321 Glendale, CA 91203	-----do-----	Ventura.
Lincoln Clay Products Co -----	Box 367 Lincoln, CA 95648	Pit -----	Placer.
Lone Star Industries Inc. <sup>5</sup> -----	2800 Campus Dr. San Mateo, CA 94403	Pit -----	Santa Cruz.
Port Costa Materials Inc -----	Box 5 Port Costa, CA 94569	Pit -----	Contra Costa.
<b>Diatomite:</b>			
Grefco Inc -----	3425 Lomita Blvd. Torrance, CA 90509	Surface mine and plant.	Santa Bar- bara and Shasta.
Manville Products Corp -----	2500 Miguelito Rd. Lompoc, CA 93436	-----do-----	Santa Bar- bara.
<b>Feldspar:</b>			
California Silica Products Co. <sup>6</sup> -----	Box 248 31302 Ortega Hwy. San Juan Capistrano, CA 92693	-----do-----	Orange.
Crystal Silica Co -----	3231 Oceanside Dr. Oceanside, CA 92054	Mine and plant	San Diego.
<b>Gold:</b>			
Gold Fields Mining Corp. <sup>7</sup> -----	HCR 76 Glamis 100 Brawley, CA 92227	Surface mine	Imperial.
Homestake Mining Co. <sup>7</sup> -----	650 California St. San Francisco, CA 94108	Surface mine and plant.	Napa.
<b>Gypsum:</b>			
USG Corp -----	Plaster City, CA 92269	-----do-----	Imperial.
<b>Lime:</b>			
Kaiser Aluminum & Chemical Corp. <sup>8</sup> -----	Box 1938 Salinas, CA 93901	-----do-----	Monterey.
National Refractories & Minerals Corp. -----	Moss Landing, CA 95039	-----do-----	Do.
<b>Perlite:</b>			
American Perlite Co -----	11831 Vose St. North Hollywood, CA 91605	Surface mine and mill.	Los Angeles.
<b>Pumice:</b>			
American Pumice Products Inc -----	17992 Mitchell, South Irvine, CA 92714	-----do-----	Inyo.
Tionesta Aggregates Co -----	13290 Hodge Dr. Reno, NV 89511	Surface mine	Siskiyou.
<b>Rare earths:</b>			
Molycorp Inc -----	Union Oil Center 461 South Boylston St. Los Angeles, CA 91017	-----do-----	San Bernar- dino.
<b>Sand and gravel (construction):</b>			
CalMat Co -----	Box 2950 Terminal Annex Los Angeles, CA 90051	Pits -----	Various.
Koppers Co. Inc., Kaiser Sand & Gravel Co. -----	Box 580 Pleasanton, CA 94566	-----do-----	Do.
Livingston-Graham -----	16080 East Arrow Hwy. Irwindale, CA 91706	-----do-----	Do.
Owl Rock Products Co -----	Box 330 Arcadia, CA 91006	-----do-----	Do.
Pleasanton Gravel Co -----	Box 850 Pleasanton, CA 94566	Pit -----	Alameda.
A. Teichert & Sons Inc., Teichert Aggregates. -----	3500 American RV Dr. Sacramento, CA 95813	Pits -----	Various.
<b>Talc and pyrophyllite:</b>			
Pfizer Inc. <sup>9</sup> -----	Box 558 Lucerne Valley, CA 92356	Surface mine and plant.	Inyo.
Western Source Inc -----	Box 280 San Andreas, CA 95249	Surface mine and mill.	Calaveras.

See footnotes at end of table.

Table 6.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Tungsten ore and concentrate: Teledyne Tungsten-----	4709 North El Capitan Ave. Suite 109 Fresno, CA 93711	Underground mine and plant.	Madera.
U.S. Tungsten Corp., a subsidiary of Strategic Minerals Corp. (Stratcor). <sup>10</sup>	Route 2 Bishop, CA 93514	-----do-----	Inyo.
Vermiculite (exfoliated): W. R. Grace & Co-----	1114 Avenue of the Americas New York, NY 10036	Plants-----	Alameda and Orange.

<sup>1</sup>Also lime, potassium salts, sodium carbonate, and sodium sulfate.

<sup>2</sup>Also salt.

<sup>3</sup>Also clays, gypsum, and iron ore.

<sup>4</sup>Also clays.

<sup>5</sup>Also cement and industrial sand.

<sup>6</sup>Also industrial sand.

<sup>7</sup>Also silver.

<sup>8</sup>Also magnesium compounds.

<sup>9</sup>Also clays and wollastonite.

<sup>10</sup>Also copper and molybdenum.

# The Mineral Industry of Colorado

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

Jane P. Ohl<sup>1</sup> and Mark W. Davis<sup>2</sup>

The value of nonfuel minerals produced in Colorado in 1986 was \$370 million, about 9% lower than in 1985 and 62% lower than in 1981. The downtrend in production value, beginning in 1981 and interrupted only in 1984, continued. Mining employment also was down.

However, very significant production increases were reported for the metallic minerals copper, gold, lead, silver, and zinc. Cleanup at Uravan and Rifle mills and

settling ponds resulted in a very large increase in the recovery of vanadium.

Nationwide, Colorado ranked 23d in value of nonfuel mineral production, compared with 19th in 1985 and 7th in 1981. Twenty nonfuel minerals were produced in the State: 12 industrial minerals and 8 metals. Industrial mineral values, surpassing metals for the first time in importance, contributed 51.3% of the total value.

Table 1.—Nonfuel mineral production in Colorado<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons...	308	\$2,111	303	\$1,743	242	\$1,523
Gem stones-----	NA	*80	NA	*80	NA	100
Gold (recoverable content of ores, etc.)						
troy ounces...	60,010	21,643	43,301	13,755	120,347	44,317
Gypsum----- thousand short tons...	291	W	233	1,800	W	W
Sand and gravel:						
Construction----- do....	28,024	87,324	*27,500	*88,000	23,233	70,095
Industrial----- do....	149	2,213	W	W	W	W
Silver (recoverable content of ores, etc.)						
thousand troy ounces...	2,200	17,909	549	3,370	645	3,526
Stone:						
Crushed----- thousand short tons...	*7,200	*26,200	7,037	25,930	*8,000	*30,700
Dimension----- do....	r 2	r *204	2	204	e 4	e 255
Combined value of cement, copper, iron ore (usable, 1984-85), lead, lime, molybdenum, peat, perlite, pyrites (1984-85), salt (1984), tin (1984-85), tungsten ore and concentrate, vanadium, zinc, and values indicated by symbol W-----	XX	278,609	XX	r 273,611	XX	219,492
Total-----	XX	r 436,293	XX	r 408,493	XX	370,008

\*Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Colorado in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Arapahoe	Sand (industrial).
Boulder	Cement, stone (crushed), clays, peat.
Chaffee	Lime, peat.
Clear Creek	Molybdenum, gold, silver, copper, lead.
Costilla	Stone (crushed).
Custer	Perlite.
Dolores	Stone (crushed), gold, silver, copper, lead.
Douglas	Clays.
Eagle	Gypsum, stone (crushed).
Elbert	Clays.
El Paso	Stone (crushed), sand (industrial), clays.
Fremont	Cement, stone (crushed), gypsum, clays.
Garfield	Stone (crushed).
Jefferson	Stone (crushed), clays.
Lake	Molybdenum, zinc, gold, lead, tungsten, silver, pyrites, copper, tin.
Larimer	Cement, stone (crushed), stone (dimension), gypsum.
Mineral	Silver, lead, copper, gold.
Montrose	Vanadium.
Ourray	Silver, gold, lead, zinc, copper.
Park	Peat.
Pitkin	Iron ore.
Pueblo	Clays.
Routt	Stone (crushed).
Saguache	Gold, silver.
San Juan	Gold, zinc, silver, lead, copper.
Teller	Gold, peat, stone (crushed), silver.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—Most industrial mineral values were down from 1985 levels, reflecting the continuing downtrend in Colorado highway and building construction activities. Exceptions to the downward trend were crushed stone and lime. Sand and gravel for construction, although down more than 20%, accounted for 37% of the value of all industrial minerals produced; and construction sand and gravel plus cement accounted for well over 80% of industrial mineral value. Nevertheless, local opposition to visible industrial mineral operations was strong.

The State ranked first in the Nation in output of molybdenum, a steel-alloying agent, but because of the slowdown in domestic steel production, mine output was down about 8% and unit price decreased more than one-quarter from that of 1985. Molybdenum accounted for nearly one-third of the State's metal value in 1986. Future molybdenum production was expected to be sharply curtailed until prices rise and the world's molybdenum glut has been absorbed.

The dramatic rise in gold output resulted mainly from the opening of a large new open pit mine, the Summitville Mine, and the return to operation of Colorado's other major gold producer, the underground Sunnyside Mine. Also of note was the very large

gold output from heap-leached dump materials in the Cripple Creek-Victor area.

**Employment.**—According to the College of Business and Administration at the University of Colorado and the Division of Commerce and Development of the Colorado Department of Local Affairs, the goods-producing sectors—mining, construction, and manufacturing—lost jobs for the second consecutive year. Mining contributed about 1.8% of total employment in the State, compared with 2.8% in 1982.

Employment in mining, however, was of primary importance in some localities such as Teller County (Cripple Creek-Victor) where unemployed citizens asked local boards for relief from taxation and zoning regulations because of the dearth of mining jobs.

**Environment.**—Environmental problems associated with mining in Eagle, Lake, Montrose, Teller, and other counties were being litigated, resolved, or considered for remedial action. The Colorado Mined Land Reclamation Division, Inactive Mine Reclamation Program, had completed in the past several years 150 reclamation projects in 26 counties. The program efforts were concentrated in the reclamation of coal minesites, but another goal was to protect the public safety in several metal mining districts where abandoned open shafts exist.

Table 3.—Indicators of Colorado business activity

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	3,190	3,234	3,267
Total civilian labor force	do.	1,714	1,719	1,694
Unemployment	percent	5.6	5.9	7.4
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup>	thousands	35.9	32.9	27.4
Metal mining	do.	5.7	4.1	3.8
Nonmetallic minerals except fuels <sup>2</sup>	do.	.9	1.0	.9
Coal mining <sup>3</sup>	do.	3.9	3.8	3.4
Oil and gas extraction	do.	25.7	24.1	19.5
Manufacturing total	do.	195.3	192.2	185.3
Primary metal industries <sup>4</sup>	do.	3.7	3.4	3.0
Stone, clay, and glass products	do.	10.0	9.8	8.8
Chemicals and allied products	do.	8.2	8.6	8.2
Construction	do.	89.9	86.3	76.4
Transportation and public utilities	do.	87.2	88.5	87.7
Wholesale and retail trade	do.	345.9	352.1	348.9
Finance, insurance, real estate	do.	94.7	95.8	97.6
Services	do.	309.2	321.9	324.9
Government and government enterprises	do.	244.4	248.9	254.0
<b>Total<sup>5</sup></b>		<b>1,402.3</b>	<b>1,418.7</b>	<b>1,402.2</b>
<b>Personal income:</b>				
Total	millions	\$44,949	\$47,489	\$49,771
Per capita		\$14,092	\$14,683	\$15,234
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		40.9	40.2	39.9
Total average hourly earnings, production workers		\$9.2	\$9.5	\$9.8
<b>Earnings by industry:<sup>4</sup></b>				
Farm income	millions	\$545	\$498	\$648
Nonfarm	do.	\$33,642	\$35,661	\$37,183
Mining total	do.	\$1,620	\$1,591	\$1,442
Metal mining	do.	\$218	\$176	\$178
Nonmetallic minerals except fuels	do.	\$26	\$27	\$7
Coal mining	do.	\$216	\$220	\$206
Oil and gas extraction	do.	\$1,161	\$1,166	\$1,052
Manufacturing total	do.	\$5,231	\$5,478	\$5,673
Primary metal industries	do.	\$138	\$117	\$107
Stone, clay, and glass products	do.	\$293	\$295	\$295
Chemicals and allied products	do.	\$276	\$299	\$302
Petroleum and coal products	do.	\$40	\$39	\$39
Construction	do.	\$2,891	\$2,883	\$2,851
Transportation and public utilities	do.	\$2,812	\$2,958	\$3,088
Wholesale and retail trade	do.	\$5,695	\$5,971	\$6,086
Finance, insurance, real estate	do.	\$2,283	\$2,528	\$2,776
Services	do.	\$7,134	\$7,841	\$8,407
Government and government enterprises	do.	\$5,798	\$6,236	\$6,666
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>5</sup>		44,369	32,824	30,961
Value of nonresidential construction <sup>5</sup>	millions	\$1,775.5	\$1,409.1	\$1,116.3
Value of State road contract awards <sup>5</sup>	do.	\$305.0	\$337.3	\$291.2
Shipments of portland and masonry cement to and within the State	thousand short tons	1,704	1,597	1,472
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$436.3	\$408.5	\$370.0
Value per capita		\$137	\$126	\$113

<sup>p</sup>Preliminary. <sup>f</sup>Revised.<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; totals may not add because of inclusion of data from other sources.<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>3</sup>Data may not add to totals shown because of independent rounding.<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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



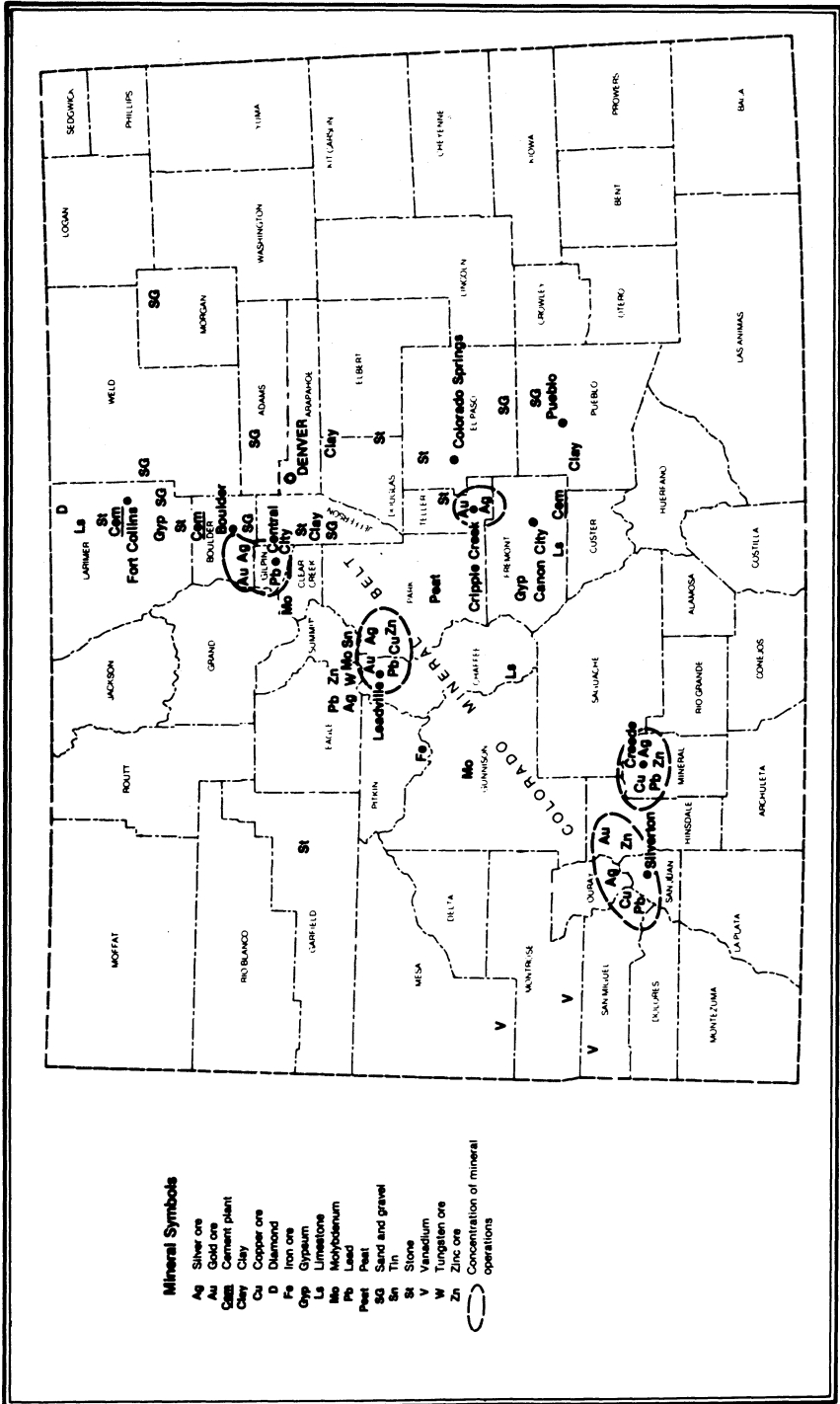


Figure 1.—Principal mineral-producing localities in Colorado.

The U.S. Environmental Protection Agency (EPA) announced on May 19 its decision to make the Eagle zinc mine in Eagle County eligible for cleanup under the Superfund program (Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the Superfund Amendments and Reauthorization Act of 1986). The State brought suit against the Eagle Mine owner, Gulf + Western Industries Inc., to encourage some action.

At midyear 1986, the State attorney general filed a class action suit in Leadville against 2,300 residential and commercial property owners in an effort to force the cleanup of the California Gulch and Yak Tunnel Superfund sites in Lake County. The move was rejected by a Leadville judge.

Among other mining sites added to either the Federal Superfund or Colorado's Mined Land and Reclamation Board lists, or for which agreements were reached in 1986, were the Smuggler Mine near Aspen, Pitkin County; two cyanide heap-leaching operations of Newport Minerals Co. of White Plains, NY, near Cripple Creek, Teller County (Newport Minerals filed a chapter 11 petition with the U.S. Bankruptcy Court, Southern District of New York, in November 1986); Idarado Mining and Milling Co.'s (Newmont Mining Co.) Red Mountain Telluride (Idarado) Mine; Union Carbide Corp.'s (Umetco Minerals Corp.) mining town of Uravan, Montrose County; and ASARCO Incorporated's Globeville cadmium smelter in north Denver.

**Exploration Activities.**—Encouraged by the upswing in precious metal prices during 1986, more than two dozen companies explored for or were developing gold and silver deposits. Principal activities were in Boulder, Conejos, Custer, Fremont, Garfield, Gunnison, Lake, Mineral, Moffat, Park, San Juan, and Teller Counties.

United States Borax & Chemical Corp., a subsidiary of Rio Tinto Zinc Corp., delineated 720,000 short tons of gold ore reserves near Dawson Mountain, southwest of Canon City. The reserve grade was 0.07 to 0.19 troy ounce of gold per ton.

Leadville Corp. operated a mill at String-

town and the Diamond shaft-Resurrection gold mine project east of Leadville. Measured, indicated, and inferred reserves totaled 519,000 short tons, with an average grade of 0.34 troy ounce of gold, 3.25 troy ounces of silver, and 4% lead per ton. Leadville Mining and Milling Corp., also in Lake County, planned to begin development work from the Hopemore shaft in early 1987.

Crown Resource Corp. and Sutton Resources Inc.'s joint venture property (Bulldog Mountain) north of Creede was leased to and being drilled by Homestake Mining Co., which has been doing \$2.5 million worth of underground and surface exploration on the East Amethyst fault system since 1984. Mesa Limited Partnership, Amarillo, TX, also was drilling north of the Emperius Mine along the Amethyst vein. Mesa absorbed Pioneer Nuclear Inc. in July 1986.

Hecla Mining Co. disposed of its interests in silver and lead properties in Lake and Park Counties during the year. Cripple Creek and Victor Gold Mining Co., a joint venture of Golden Cycle Gold Corp. and Texasgulf Minerals and Metals Inc., planned three leach pads southeast of the town of Cripple Creek. The first pad was to employ 60 persons and operate for 3 to 4 years. Levon Resources Ltd., a Canadian company, leased property on Carbonate Hill in the Cripple Creek area from Lula Gold Mining Co. Since mid-1985, 120 holes have been drilled on the 350-acre site.

**Legislation and Government Programs.**—Colorado received \$79.8 million from various royalties and taxes in 1986 from the mining and oil industry, according to the Colorado Geological Survey. The amount compared with \$80.9 million in 1985 and \$101 million during the boom year of fiscal year 1981-82.

The U.S. Bureau of Mines and the U.S. Geological Survey reported on the mineral resources of wilderness study areas in Alamosa, Chaffee, Delta, El Paso, Fremont, Hinsdale, Mesa, Montrose, Pitkin, and Teller Counties.<sup>3</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Colorado's portland cement output and value declined in 1985 and again in 1986. Masonry cement output and value declined in each of the past 3 years.

Ideal Basic Industries Inc. and Southwestern Portland Cement Co. operated three plants along the Front Range of the Rocky Mountains. Ideal Basic's two plants served northern and central Colorado, while Southwestern's plant, which also served the northern population, is closer to the greater Denver area. The two firms operated three wet-process and two dry-process kilns. A 68.3% stake in Ideal Basic was acquired at yearend by Holderbank Financiere Glarus Ltd. of Switzerland. As of June 30, 1986, Ideal Basic had a negative net worth of about \$150 million and was considering declaring bankruptcy.

Sales of finished portland cement declined less precipitously in 1986 than in 1985. Unit price per short ton dropped nearly 4%. Shipments of gray finished portland cement, classified as "general-use and high-early-strength" type, declined in quantity and value. Sales of the very high sulfate resistance variety rose; however, its average value declined nearly 5%.

Raw materials consumed were principally limestone and sandstone, with smaller amounts of gypsum, iron ore, and various chemicals.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (73.3% of shipments); concrete product manufacturers; highway contractors; building material dealers; other contractors; Federal, State, and other government agencies; and other miscellaneous users.

**Clays.**—Colorado was a relatively small producer of clays, with about one-half of 1% of the Nation's total. Output declined 20% and total value declined nearly 13% from levels reported for 1985. More than 97% of production was common clay. Some fire clay and very small amounts of swelling and nonswelling bentonite also were produced.

Clay was produced from 28 pits in 8 counties—more than two-thirds of clay values were from Boulder, Douglas, Elbert, and Jefferson Counties. Leading companies were Lakewood Brick and Tile Co., Robinson Brick Co., and General Refractories Co.

Colorado clays were used for animal feed; common, face, and refractory brick; drilling

muds; flower pots; and waterproofing seals. Average unit price of clays per short ton ranged from \$6.09 for common clay to \$13.29 for fire clay, and averaged \$6.29.

**Gem Stones.**—Amethyst Queen Mine, Mesa County, continued to produce amethyst, which was cut in the United States and the Far East. The commercial mining of topaz continued in the Terryall Mountains. The King Turquoise Mine near Manassa also produced gem stone material during the year.

Lapis lazuli occurs at the Blue Wrinkle Mine 11 miles northeast of Crested Butte, Gunnison County. The mine, at 12,600 feet on North Italian Mountain and owned by Anchor Coal Co. of Tulsa, OK, has been idle since 1984; however, Anchor Coal has spent \$1 million, hoping to start production in the summer of 1988.

Museum-quality amazonite was discovered near Florissant, Teller County; amazonite also was found at Devil's Head, Douglas County. Gem-quality garnets and light-colored topaz are found in the Ruby Mountain area, 7 miles south of Buena Vista, Chaffee County.

**Gypsum.**—Crude gypsum output declined slightly from that of 1985 and the unit price fell moderately to \$7.07 per short ton. Genstar Corp., parent of Genstar Gypsum Products Co. (formerly Genstar Building Materials Co.), was acquired by Amasco, a Canadian conglomerate. Subsequently, gypsum facilities at Florence and Coaldale were sold to Domtar Inc. in the fall of 1986.<sup>4</sup>

Planter's Plus International Ltd. continued to operate the Wellsville gypsum quarry and crushing plant southeast of Salida. Established in the 1930's, the firm serviced only out-of-State markets in Kansas, Missouri, and Oklahoma until increasing its market area to include local Chaffee County farmers and stores in 1986. Planter's Plus was called U.S. Soil until June 1985.

**Lime.**—After a very poor production year in 1985, lime output increased 75% in 1986. The increase, however, was 39% below the production level of 1984. The Great Western Sugar Co. of Denver, a subsidiary of Hunt International Resources Corp. of Dallas, TX, filed for chapter 11 Federal bankruptcy in March 1985 and reported no production that year from its facilities in Morgan and Weld Counties. In 1986, The Western Sugar Co., a subsidiary of a British firm, Tate and Lyle, purchased Great Western Sugar's facilities and resumed lime production.

Lime was used for neutralizing acid wastes, precipitating heavy metals from waste solutions, removing sulfur dioxide from stack gases, maintaining pH control while leaching precious metals, and in sugar refining. Holly Sugar Corp. of Colorado Springs developed a rhizomania-resistant beet seed. The control of rhizomania, a fungus that has damaged California and Texas sugar beet fields in recent years, would ensure good crops in the future.

Lime sales were strong in 1986 because of good sugar beet crops, high gold prices, waste cleanup, and emission control, but the average unit price was slightly less than that of 1985.

**Peat.**—Peat recovery from Colorado bog material fell moderately, but the unit price per short ton rose slightly. Residents of Eldora, an unincorporated townsite, filed a complaint with the Boulder County Land Use Department objecting to peat mining on private land near Middle Boulder Creek. Owners had applied for a State grading permit to mine 1.4 acres of their 4-acre holdings. The County Parks Planner considered designating the site as a significant wetland, disallowing mining.

**Perlite.**—Crude perlite was produced by Persolite Products Inc. from its Rosita Mine in Custer County; output declined significantly from that of 1985. Two companies produced expanded perlite: Persolite at its plant at Florence, Fremont County, and Grefco Inc. at its Building Products Div. plant at Antonito, Conejos County. The expanded product was used as filter aid, cavity-fill insulation, concrete aggregate, fillers, and other uses.

**Pyrites.**—Apache Pyrite Joint Venture, formed in March 1986, processed pyrite from a pre-1950's tailings pond at the west end of California Gulch in Lake County. None of the recovered high-grade pyrite was used to make sulfuric acid; instead it was used as a raw material to produce amber-colored bottle glass and as a filler material in the production of abrasive wheels and semimetallic brakeshoes. A unique feature

of the recovery operation was the resulting reclamation of land scarred by previous mining and milling operations. More than a dozen employees worked at the mill and tailings site in 1986.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Forty-nine counties were the sites of 317 construction sand and gravel pits during 1986. From these pits, \$70 million worth of construction material for highways and buildings was extracted, placing Colorado 10th of 50 States. Unit value ranged from \$1 per short ton in some plains counties, where materials were extracted from riverbeds and adjacent land, to \$5.69 in a south-central mountainous area, where much of the construction material requirement was met by quarried granite. Average unit value statewide was \$3.02 per short ton.

Mobile Premix Sand & Gravel Co. and Western Mobile Premix Inc. (subsidiaries of Western Mobile Inc. as of December 2, 1986) ranked first in output. Mobile Premix had sand and gravel operations in 9 northern Colorado counties; 124 other companies and highway departments, 107 of which produced less than 300,000 short tons each annually, also had operations in the State.

Elam Construction Co. in Pitkin County, Grace Construction Co. in Routt County, Pioneer Sand Co. in El Paso County, GEI Products in Boulder County, and Zigan Sand & Gravel Co. in Adams County were among Colorado firms meeting citizen resistance against continuing or expanding their construction sand and gravel or crushed stone pits or quarries.

Construction sand and gravel was used, in decreasing order of volume consumed, for road base and coverings, concrete aggregates, fill, and several uses requiring lesser volumes of material.

**Table 4.—Colorado: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,893	\$19,545	\$3.99
Plaster and gunit sands -----	70	275	3.93
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	101	301	2.98
Asphaltic concrete aggregates and other bituminous mixtures -----	2,337	7,985	3.42
Road base and coverings <sup>1</sup> -----	5,663	14,398	2.54
Fill -----	2,342	4,059	1.73
Railroad ballast -----	178	749	4.21
Roofing granules -----	23	98	4.26
Other -----	197	808	4.10
Other unspecified <sup>2</sup> -----	7,430	21,877	2.94
Total or average -----	<sup>3</sup> 23,233	70,095	3.02

<sup>1</sup>Includes road and other stabilization (lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Cherry Creek Sand Specialties Co. in Arapahoe County and Colorado Silica Sand Inc. in El Paso County reported the State's only industrial sand production. Output of industrial sand, used mainly for sandblasting, was down 42% from that of 1985.

**Sodium Bicarbonate.**—Wolf Ridge Corp. (a subsidiary of Industrial Resources Inc. of Lakewood) applied for a U.S. Bureau of Land Management permit to construct a pilot nahcolite solution mine in central Rio Blanco County. Its plan was to extract 36,000 short tons of the naturally occurring sodium bicarbonate over a 2-year period. When expanded to commercial size, the mine and mill would be capable of extracting and processing 125,000 tons annually. Wolf Ridge's project would make it the only producer of natural sodium bicarbonate in the Nation.<sup>5</sup>

Sodium bicarbonate is used in air pollution control, foodstuffs, rubber, textiles, and other applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Almost all of the stone produced was crushed stone. Production increased an estimated 14% in volume and 18% in value over 1985 levels.

Western Mobile was formed by the sale of M.P.M. Inc. (a Denver-based producer of ready-mixed concrete and construction aggregates) to joint venture partners Koppers Co. Inc. of Pittsburgh, PA, and Redland PLC, a British construction materials firm,

for \$37.5 million. The Koppers subsidiaries—Western Paving Construction Co. of Denver, the Sterling Co. of Wyoming and Colorado, Broderick and Gibbons Inc. of Pueblo, and a Kansas firm—were included in the new affiliation. Western Mobile was to be based in Denver and employ 1,500 persons in 4 States.

The Wesley D. Conda Inc. mining company met with considerable local opposition to its proposal to expand a 17-year-old quarry from 9.9 acres to 67 acres. The expanded quarry, on State-owned land adjacent to Eldorado Springs State Park in Boulder County, would produce 200,000 short tons of rock per year. Other proposals from Front Range firms to quarry and crush stone met with strong opposition by residents of El Paso, Jefferson, Larimer, and other counties. Crushed stone producers, hoping to provide a sand and gravel substitute to compensate for the loss of stream gravels that have been built over, looked to these other sources for raw materials; but opponents alleged that hillside scars would be visible for long periods before reclamation efforts could take effect, and dust from quarrying and trucking would affect the quality of residents' lives.

**Dimension.**—Dimension stone output doubled that of earlier years, but the unit price fell nearly 38%.

A small-mine operator proposed to operate a black marble quarrying operation on a 472-acre claim along Conundrum Creek in Pitkin County, on U.S. Forest Service land. The marble at the Conundrum quarry, first worked in the early 1900's but inactive since then, can be found in a variety of colors from blue-gray to green-gray to black. In

addition to 1-ton pieces sold to sculptors, some crushed rock was to be used in plaster of paris and as a conditioner for acidic soils. The U.S. Forest Service expressed concerns about possible impacts of mine activity on bighorn sheep that winter in the area and on summer vacationers who use a nearby campground.

**Sulfur (Elemental).**—Conoco Inc. recovered elemental sulfur from acid gases at its petroleum refinery in Adams County near Denver. Elemental sulfur is not included in table 1 because it is considered a byproduct of fuel processing.

Monex Engineering Inc. of Calgary, Alberta, Canada, explored sulfur deposits near Trout Creek, southwest of Creede. The deposits had been worked sporadically in the early 1900's. If the exploration activities proved sufficient quantities of sulfur, an open pit operation was envisioned to develop the deposits. Mining activities would be controlled by the U.S. Forest Service because the deposits are in a national forest.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. exfoliated vermiculite from Montana at its Denver plant. About three-quarters of the product was used in fireproofing and block insulation.

## METALS

**Cadmium.**—Asarco recovered cadmium from flue dust, dross, and byproduct materials from out-of-State smelters at its Globe high-purity metals refinery in Denver. Because the origin of the processed materials could not be determined, this output was not included in the Colorado mineral production total.

**Copper.**—Copper, produced in Colorado only as a byproduct of other metal production, occurred in complex ores along with gold, lead, silver, and zinc, but composed only about 1% of the value of those ores. Three mines in Colorado reported copper production: Black Cloud (Lake County), Camp Bird (Ouray County), and Sunnyside (San Juan County). Quantity and value, although small, rose sharply from 1985 figures, 105% and 102%, respectively. The average price of copper during 1986 was \$0.661 per pound, down slightly from that of 1985.

**Gold.**—Gold produced in Colorado soared

178% above the 1985 level to 120,347 troy ounces. Total value rose 222% to \$44.3 million because of the opening of a new mine, return to activity of a second, and increased price per ounce; the average price of gold during 1986 rose \$50.58 to \$368.24 per ounce.

Black Cloud, Camp Bird, Cross, Crystal Hill, Summitville, Sunnyside, Victor, and Vulcan Mines were open all or part of 1986. Four were underground mines in various counties; three were heap leach gold and silver recovery operations, in Rio Grande, Saguache, and Teller Counties; and gold was recovered by the heap leach method at Great West Gold and Silver Inc.'s Vulcan Mine in Gunnison County. In addition, Blue Jet placer was operated by Blue Jet Mining Co. in Moffat County stream gravels.

About 95% of Asarco's Black Cloud ore is in the Mississippian Leadville Dolomite. An average of 850 short tons of ore per day was mined; after milling, concentrates were shipped to Asarco smelters at Glover, MO; Bartlesville, OK; Helena, MT; or El Paso, TX.

Disseminated ore bodies Nos. 10 and 11 at the Black Cloud Mine were discovered, and development work was to begin on No. 10. Mining was to begin in August 1988. Reserves at Black Cloud Mine were 977,000 short tons, averaging 0.08 ounce of gold, 2.46 ounces of silver, 4.45% lead, 8.95% zinc, and 0.13% copper, according to Asarco's 1986 annual report.

Chipeta Mining Corp. operated the Camp Bird Mine in Ouray County for a group called the Camp Bird Venture (includes Royal Gold Inc.). Camp Bird Mine has been in an exploration and development phase in recent years, and production was limited.

In 1986, the Camp Bird mill reported significant increases in material treated (including custom ore) and gold recovered but substantial declines in the recovery of silver, copper, and lead; and unlike 1985, no zinc was reported recovered.

Cripple Creek and Victor Gold Mining Co., a joint venture between Texasgulf Minerals of Golden, CO, and Golden Cycle Gold of Colorado Springs, was the State's second largest gold producer in 1986 leaching mine dump materials.

**Table 5.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county**

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1984, total	16	---	903,525	60,010	\$21,643,088	2,199,888	\$17,908,540
1985, total	11	---	944,556	43,301	13,754,953	548,696	3,370,200
1986:							
Boulder	1	---	W	W	W	W	W
Gunnison	1	---	W	W	W	W	W
Lake	1	---	W	W	W	W	W
Moffat	---	1	---	W	W	---	---
Ouray	1	---	7,132	576	212,106	644	3,523
Rio Grande	1	---	W	W	W	W	W
Saguache	1	---	18,615	1,026	377,814	6,257	34,226
San Juan	1	---	133,016	22,112	8,142,523	211,183	1,155,171
Teller	1	---	W	W	W	W	W
Total	8	1	<sup>2</sup> 2,843,437	<sup>3</sup> 120,347	<sup>3</sup> 44,316,580	<sup>3</sup> 644,574	<sup>3</sup> 3,525,820
	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1984, total	W	W	W	W	W	W	W
1985, total	W	W	W	W	W	W	W
1986:							
Boulder	---	---	---	---	---	---	W
Gunnison	---	---	---	---	---	---	W
Lake	W	W	W	W	W	W	W
Moffat	---	---	---	---	---	---	W
Ouray	1	\$977	3	\$1,287	---	---	\$217,893
Rio Grande	---	---	---	---	---	---	W
Saguache	---	---	---	---	---	---	412,040
San Juan	411	598,911	2,365	1,149,581	W	W	W
Teller	---	---	---	---	---	---	W
Total	W	W	W	W	W	W	<sup>3</sup> 65,446,561

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Operations from which gold and silver are recovered as byproducts from sand and gravel operations are not counted as producing mines.<sup>2</sup>Does not include gravel washed.<sup>3</sup>Includes items indicated by symbol W.**Table 6.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Amalgamation	14,102	W	---	---	---
Cyanidation	W	67,411	---	---	---
Smelting of concentrates	W	W	W	W	W
Direct smelting of ore	W	W	---	---	---
Total lode material	W	1644,574	W	W	W
Placer	W	---	---	---	---
Grand total	<sup>1</sup> 120,347	<sup>1</sup> 644,574	W	W	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes items indicated by symbol W.

Table 7.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by class of ore or other source material

Source	Number of mines <sup>1</sup>	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold <sup>2</sup> -----	7	2,643,354	103,169	W	412	2,368	W
Zinc -----	1	W	W	W	W	W	W
Other lode material:							
Gold cleanup -----	1	W	W	W	--	--	--
Total lode -----	8	<sup>2</sup> 2,843,437	W	<sup>3</sup> 644,574	W	W	W
Placer -----	1	--	W	--	--	--	--
Grand total -----	9	<sup>2</sup> 2,843,437	<sup>3</sup> 120,347	<sup>3</sup> 644,574	W	W	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Detail may not add to total shown because some mines produce more than one class of material. Operations from which metals are recovered only from cleanup are not counted as producing mines.

<sup>2</sup>Includes material that was leached.

<sup>3</sup>Includes items indicated by symbol W.

Echo Bay Mines Ltd.'s Sunnyside Mine, San Juan County, was reopened in April and resumed commercial production in August 1986. Acquired from Standard Metals Corp. in November 1985, the mine was operated by the Sunnyside Gold Corp. An average of 682 tons of ore per day was trucked 8 miles to the Mayflower mill. Sunnyside ore averaged between 0.217 and 0.157 ounce of gold per ton. Costs of recovery improved to \$297 per ounce of gold, from \$380 early in the year, and averaged \$336, according to Echo Bay's 1986 annual report. Gold content of proven and probable ore reserves at the Sunnyside Mine was 116,100 ounces (0.25 ounce per ton) at yearend 1985 and 88,500 ounces (0.19 ounce per ton) at yearend 1986. An underground and surface exploration program was planned by Echo Bay. The Mayflower mill, constructed in 1926 and put into operation in 1929-30, may be refurbished and updated.

Gold Hill Ventures, a limited partnership, was completing a gold telluride 50- to 100-ton-per-day mill, the Gold Hill mill, in Boulder County. Ore was to be processed from the Cash and Who Do Mines.

Great West Gold was granted permits for a tank-leaching operation at the silver-gold Dinero Tunnel dump near Leadville. Great West Gold also had a gold heap leach operation at the Vulcan (Good Hope) Mine in Gunnison County.

Hendricks Mining Co., lessee and operator of the Cross Mine near Caribou, Boulder County, reopened the mine in the fall. Ore grading 0.5 ounce of gold and 2 to 4 ounces of silver per ton was sent to the nearby mill. The resultant concentrates were shipped to British Columbia, Canada, or Fountain, CO,

to be smelted.

Marathon Gold Corp. and its affiliate, Centennial Gold Corp., merged with Hampton USA (controlled by Dallhold Investments Partnership Ltd., of Australia). Marathon had interests in gold and rare-earth properties north of Craig in Moffat County.

In late January, Nerco Minerals Co. and its joint venture partner, Silver State Mining Corp., temporarily closed the Victor Mine gold operation because of problems related to expansion of the mine and the processing plant.

**Lead.**—Lead output increased 37% but was nearly one-quarter less than that of 1984. The Black Cloud, Camp Bird, and Sunnyside Mines reported lead output.

**Molybdenum.**—AMAX Inc.'s Henderson and Climax Mines operated at about 50% below capacity, owing to reduced worldwide demand for molybdenum in 1986. The two mines produced 45.5 million pounds of molybdenum contained in concentrates, or about 26% of the Western World's supply, according to the company's 1986 annual report. The average price per pound of molybdc oxide fell from \$5.90 in 1982 to \$2.87 in 1986; effective October 1986, AMAX published a list price of \$3.45.

To balance production with demand, output was reduced from 32,500 to 27,000 short tons per day at the Henderson Mine (Clear Creek County) and from 21,000 to 6,000 tons per day at the Climax Mine (Lake County). After the cutbacks, Henderson employed 700 persons and Climax, 200.

Climax Mine workers agreed in August to accept a 13% cut in wages; they were represented by the Oil, Chemical and Atomic Workers International Union and the



**International Brotherhood of Electrical Workers.** Henderson Mine workers were not unionized and were unaffected by the agreement.

Reserves at Climax were 238 million tons, grading 0.33% molybdenum disulfide, and at Henderson, 226 million tons, grading 0.37%.

**Rare Earths.**—Molycorp Inc. processed concentrates recovered from uranium leach solutions at its yttrium oxide and high-purity lanthanum production plant at Louviers, Douglas County. The concentrates were shipped to Colorado from a mine at Elliot Lake in Canada.

**Silver.**—Output of silver increased 17% from that of 1985, but the average price fell to \$5.47 per troy ounce, compared with \$6.14 in 1985. Silver was reported from Black Cloud, Camp Bird, Cross, Crystal Hill, Summitville, Sunnyside, and Victor Mines, and from a heap-leached dump near the Cripple Creek-Victor area. The last shipment of silver ore from Pioneer Nuclear's Emperius Mine north of Creede was made in March 1985. The mine was to remain on standby. Homestake's Bulldog Mountain Mine, the State's largest silver producer through 1984, was idle in 1985, and allowed to fill with water in November 1986.

Hecla Mining wrote off about \$5.5 million on its interest in the Revenue-Virginus Mine in Ouray County. The mine had been acquired as part of the merger with Ranchers Exploration and Development Corp. in 1984. Hecla Mining also turned over its claim in the Sherman Mine near Leadville to Leadville Corp.

**Tungsten.**—Tungsten output decreased by nearly two-thirds as production was nearly halted at the Climax Mine where it was a byproduct of molybdenum processing.

**Vanadium.**—Vanadium was recovered principally from cleanup operations at mills and settling ponds at Uravan and Rifle.

At yearend, Cotter Corp. announced plans to close its Canon City uranium-vanadium mill on January 30, 1987, and lay off 115 employees because of the continuing depressed uranium-vanadium market.

Umetco's uranium-vanadium mill at Uravan, Montrose County, closed in 1984 and remained closed through 1986. The Colorado Department of Health had a provisional agreement with Union Carbide-Umetco to store radioactive waste from Denver (63,000 cubic yards) at the Uravan millsite.

**Zinc.**—Zinc output was up nearly one-third from that of 1985 but was lower than 1984 output. Total value increased 21%, but average unit price fell \$52 to \$838 per metric ton in 1986. Zinc production was reported from Asarco's Black Cloud and Echo Bay's Sunnyside Mine. The Black Cloud Mine reported 8.95% zinc in the ore.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.

<sup>2</sup>Chief, Minerals and Mineral Fuels Resources, Colorado Geological Survey.

<sup>3</sup>Johnson, E. R., J. R. Hassemer, and B. J. Hannigan. Mineral Resources of the Papa Keal and Zapata Creek Wilderness Study Areas, Alamosa County, Colorado. U.S. Geol. Surv. Bull. 1716-D, 1986, pp. D1-D6.

Korzeb, S. L. Mineral Investigation of the Redcloud Peak and the Handies Peak Wilderness Study Areas, Hinsdale County, Colorado. BuMines MLA 68-86, 1986, 105 pp.

Leibold, A. M., R. G. Worl, R. A. Martin, and J. E. Zeltin. Mineral Resources of the Browns Canyon Wilderness Study Area, Chaffee County, Colorado. U.S. Geol. Surv. Bull. 1716-C, 1986, pp. C1-C14.

Lindsey, D. A., J. R. Hassemer, R. A. Martin, R. B. Taylor, and T. J. Kreidler. Mineral Resources of the Beaver Creek Wilderness Study Area, Fremont, El Paso, and Teller Counties, Colorado. U.S. Geol. Surv. Bull. 1716-B, 1986, pp. B1-B17.

Schreiner, R. S. Mineral Investigation of a Part of the Dominguez Canyon Wilderness Study Area, Delta, Mesa, and Montrose Counties, Colorado. BuMines MLA 65-86, 1986, 13 pp.

Soulliere, S. J., M. A. Arnold, S. E. Kluender, and J. E. Zeltin. Mineral Resources of the Eagle Mountain Wilderness Study Area, Pitkin County, Colorado. U.S. Geol. Surv. Bull. 1717-B, 1986, pp. B1-B9.

<sup>4</sup>Rock Products. Rock Newscope. V. 89, No. 11, Nov. 1986, p. 9.

<sup>5</sup>U.S. Department of the Interior, Bureau of Land Management, White River Resource Area, Craig District, Colorado. Final Environmental Impact Statement: Wolf Ridge Corp. Mine Plan for a Nahcolite Solution Mine. July 1987, pp. 1-1 to 4.3-8.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Ideal Basic Industries Inc. <sup>1</sup> -----	Box 8789 750 17th St. Denver, CO 80201	Plants -----	Fremont and Larimer.
Southwestern Portland Cement Co. <sup>1</sup> --	1111 South Colorado Blvd. Denver, CO 80222	Plant -----	Boulder.
<b>Clays:</b>			
General Refractories Co. -----	600 Grant St., Room 3000 Pittsburgh, PA 15219	Pits -----	Pueblo.
Lakewood Brick and Tile Co -----	1325 Jay St. Lakewood, CO 80214	Pits and plant --	Fremont and Jefferson.
G. W. Parfet Estate Inc -----	1213-1/2 Washington Ave. Golden, CO 80401	Pits -----	Jefferson.
Robinson Brick Co -----	Box 5243 Denver, CO 80217	Pits and plant --	Douglas, Elbert, El Paso, Jefferson.
<b>Gold:</b>			
ASARCO Incorporated <sup>2</sup> -----	Box 936 Leadville, CO 80461	Mine and mill --	Lake.
Cripple Creek and Victor Gold Mining Co. <sup>3</sup>	Box 191 Victor, CO 80860	Mine dump heap leaching.	Teller.
Summitville Consolidated Mining Co. Inc., a subsidiary of Galactic Resources Inc. <sup>3</sup>	Box 2G Del Norte, CO 81132	Open pit, vat leaching, carbon-pulp plant.	Rio Grande.
Sunnyside Gold Corp., a subsidiary of Echo Bay Mines Ltd. <sup>2</sup>	Box 177 Silverton, CO 81433	Mine and mill --	San Juan.
<b>Gypsum:</b>			
Genstar Gypsum Products Co -----	1153 State Hwy. 120 Florence, CO 81226	Mine and plant --	Fremont.
<b>Lime:</b>			
Calco Inc. -----	Box 1044 Salida, CO 81201	----do-----	Chaffee.
The Western Sugar Co., a subsidiary of Tate and Lyle.	555 17th St. Denver, CO 80202	Plants -----	Morgan and Weld.
<b>Molybdenum:</b>			
AMAX Inc. <sup>4</sup> -----	1707 Cole Blvd. Golden, CO 80401	Mines and mills --	Clear Creek and Lake.
<b>Peat:</b>			
Universal Peat Co -----	1557 South Ingalls St. Lakewood, CO 80226	Bog -----	Park.
<b>Perlite:</b>			
Grefco Inc., Building Products Div --	Box 308 Antonito, CO 81120	Plant -----	Conejos.
Persolite Products Inc -----	Box 105 Florence, CO 81226	Mine and plant --	Custer and Fremont.
<b>Sand and gravel:</b>			
Castle Concrete Co -----	Box 2379 Colorado Springs, CO 80901	Pits and plants --	El Paso and Pueblo.
Cooley Gravel Co. (J. L. Shiely Co.) <sup>1</sup> --	Box 5485 Terminal Annex Denver, CO 80217	----do-----	Adams, Arapahoe, El Paso.
Albert Frei & Sons Associates -----	11521 Brighton Rd. Henderson, CO 80640	----do-----	Adams, Clear Creek, Garfield, Weld.
Western Mobile Premix Inc. <sup>1</sup> -----	Box 5183TA Denver, CO 80217	----do-----	Various (9 counties).
Western Paving Construction Co ---	Box 21649 Denver, CO 80221	----do-----	Boulder and Weld.
<b>Stone:</b>			
Asphalt Paving Co -----	14802 West 44th Ave. Golden, CO 80401	Quarries -----	Jefferson.

<sup>1</sup>Also stone.<sup>2</sup>Also copper, lead, silver, and zinc.<sup>3</sup>Also silver.<sup>4</sup>Also tungsten.



# The Mineral Industry of Connecticut

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

By Donald K. Harrison<sup>1</sup> and Robert J. Altamura<sup>2</sup>

The value of nonfuel mineral production in Connecticut in 1986 was \$80.4 million, an \$8 million increase compared with that of 1985. Mineral commodities produced, in terms of value, were crushed stone, construction sand and gravel, feldspar, industrial sand, dimension stone, clays, and mica. Nationally, Connecticut ranked second in feldspar production. In the six-State New England region, Connecticut ranked second in crushed stone production.

In 1986, crushed stone and construction

sand and gravel accounted for nearly 90% of the State's total mineral production value. A continuing surge in construction activity in the region has, therefore, benefited producers of these commodities since both stone and sand and gravel are primarily used for construction purposes. Although no cement is produced in Connecticut, shipments into the State have nearly doubled in the past 6 years, from 590,000 short tons in 1981 to more than 1 million short tons in 1986.

Table 1.—Nonfuel mineral production in Connecticut<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons..	99	\$565	106	\$632	157	\$975
Gem stones -----	NA	W	NA	W	NA	2
Sand and gravel (construction) ----- thousand short tons..	6,718	22,817	<sup>e</sup> 6,000	<sup>e</sup> 21,000	7,254	25,984
Stone:						
Crushed ----- do .....	<sup>e</sup> 8,300	<sup>e</sup> 49,400	7,277	43,937	<sup>e</sup> 7,700	<sup>e</sup> 45,800
Dimension ----- do .....	<sup>r</sup> <sup>e</sup> 20	<sup>r</sup> <sup>e</sup> 1,285	20	1,285	<sup>e</sup> 24	<sup>e</sup> 1,653
Combined value of feldspar, lime (1984), mica (scrap), sand and gravel (industrial), and values indicated by symbol W -----	XX	5,834	XX	5,532	XX	6,040
Total -----	XX	79,901	XX	72,386	XX	80,454

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; not included in "Combined value" figure. XX Not applicable.

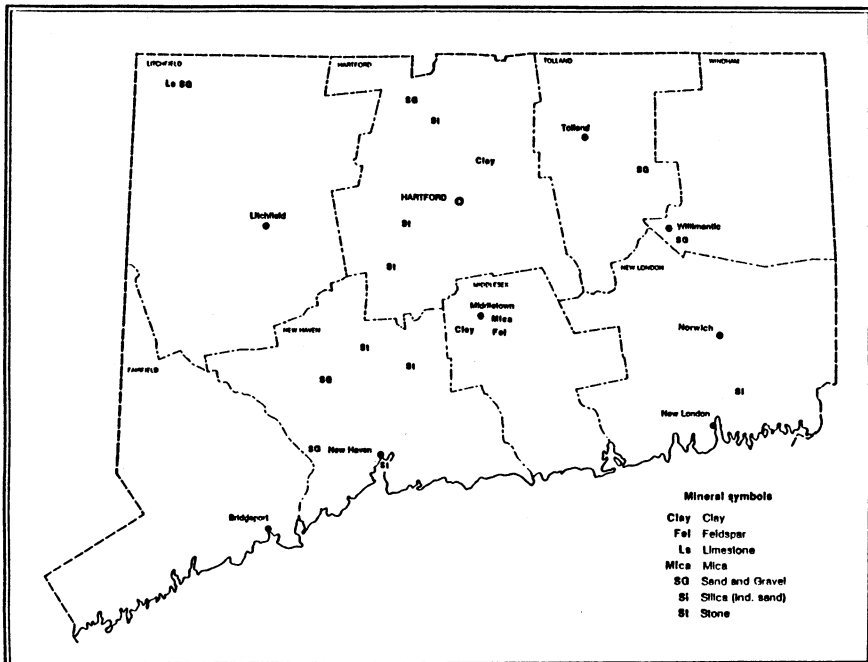
<sup>1</sup>Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

**Table 2.—Nonfuel minerals produced in Connecticut in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Hartford -----	Stone (crushed), clays.
Litchfield -----	Stone (crushed).
Middlesex -----	Feldspar, sand (industrial), mica, clays.
New Haven -----	Stone (crushed), stone (dimension).
New London -----	Sand (industrial).
Tolland -----	Stone (dimension).
Windham -----	Stone (crushed), stone (dimension).
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.



**Figure 1.—Principal mineral-producing localities in Connecticut.**

Table 3.—Indicators of Connecticut business activity

	1984 <sup>†</sup>	1985	1986 <sup>‡</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	3,153	3,171	3,189
Total civilian labor force	do	1,672	1,711	1,740
Unemployment	percent	4.6	4.9	4.7
<b>Employment (nonagricultural):</b>				
Mining total	thousands	1.5	1.6	1.6
Nonmetallic minerals except fuels <sup>1</sup>	do	.8	.9	1.0
Manufacturing total	do	415.3	408.3	395.5
Primary metal industries	do	16.1	14.7	13.7
Stone, clay, and glass products <sup>1</sup>	do	5.8	5.4	5.1
Chemicals and allied products	do	22.4	22.5	22.7
Petroleum and coal products <sup>1</sup>	do	.2	.2	.3
Construction	do	60.8	65.6	70.6
Transportation and public utilities	do	66.6	68.4	68.8
Wholesale and retail trade	do	332.8	347.4	358.4
Finance, insurance, real estate	do	123.3	130.4	139.4
Services	do	335.0	351.8	371.4
Government and government enterprises	do	185.2	188.8	195.9
Total	do	1,520.5	1,562.3	1,601.6
<b>Personal income:</b>				
Total	millions	\$53,720	\$57,813	\$65,502
Per capita	do	\$17,036	\$18,229	\$19,600
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do	42.5	41.9	41.8
Total average hourly earnings, production workers	do	\$9.2	\$9.6	\$10.1
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$154	\$153	\$169
Nonfarm	do	\$37,552	\$41,096	\$44,714
Mining total	do	\$24	\$27	\$30
Nonmetallic minerals except fuels	do	\$116	\$164	\$168
Oil and gas extraction	do	\$12,105	\$12,619	\$13,012
Manufacturing total	do	\$577	\$478	\$476
Primary metal industries	do	\$155	\$152	\$155
Stone, clay, and glass products	do	\$864	\$924	\$1,002
Chemicals and allied products	do	\$8	\$8	\$9
Petroleum and coal products	do	\$2,331	\$2,578	\$2,876
Construction	do	\$1,988	\$2,169	\$2,323
Transportation and public utilities	do	\$5,740	\$6,421	\$7,115
Wholesale and retail trade	do	\$3,198	\$3,561	\$4,319
Finance, insurance, real estate	do	\$7,743	\$8,704	\$9,750
Services	do	\$4,153	\$4,680	\$4,925
Government and government enterprises	do			
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup>	do	17,810	24,545	27,730
Value of nonresidential construction <sup>3</sup>	millions	\$810.1	\$932.8	\$1,172.5
Value of State road contract awards <sup>4</sup>	do	\$331.4	\$404.5	\$665.5
Shipments of portland and masonry cement to and within the State <sup>5</sup>	thousand short tons	775	887	1,058
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$79.9	\$72.4	\$80.5
Value per capita	do	\$25	\$23	\$25

<sup>†</sup>Preliminary. <sup>‡</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

<sup>5</sup>Has no cement-producing plants.

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.**—Construction activity in the State experienced its sixth consecutive year of growth in 1986, making the 1981-86 construction boom one of the strongest ever in Connecticut.<sup>3</sup> Value of total construction contracts in the State in 1986 was 23% higher than that of 1985. This increase compares to an overall increase of 13% for all of New England and a 2.3% decrease nationally. A breakdown of

these contracts shows that the value of nonbuilding construction recorded the greatest gain (38%), followed by residential construction (37%), and nonresidential building construction (3%).<sup>4</sup> State road contracts also increased in 1986. The State Department of Transportation issued \$501 million in contracts, more than four times the \$106 million expended in 1981. As a result of the increases in the value of

construction contracts and road repair allocations, output of the State's construction mineral commodities increased in 1986. Increases in quantity were reported for clays, dimension stone, construction sand and gravel, and crushed stone.

Although there are no metal mines in the State, the 1985 gold discovery by University of Connecticut geologists continued to stir statewide and national news media interest. Samples from the deposit near the village of Cobalt were assayed as having concentrations of gold ranging from 1.5 to 6 Troy ounces per short ton. However, because most of the deposit is on State forest land, a full evaluation or commercial mining of the deposit seems unlikely.

**Legislation and Government Programs.**—The Connecticut Department of Environmental Protection completed a draft statewide plan of environmental goals and management strategies concerning air, water, land, and other natural resources. The document, entitled "Environment/2000," was made available for public comment and would require legislative approval to become law.

"Resource Management," part III of "Environment/2000," proposed a comprehensive mineral and soil resources program. Management strategies listed for this category were fourfold: (1) determine the availability and use of nonrenewable natural

resources in the State; (2) develop uniform extraction regulations to protect the environment, ensure the future availability of the resource, and prevent its untimely exploitation; (3) achieve maximum soil conservation; and (4) ensure that Connecticut receives a fair monetary return when nonrenewable natural resources in its ownership are extracted.

The Connecticut Geological and Natural History Survey (CGNHS) continued programs on the collection, interpretation, and dissemination of information on the State's natural resources. Major efforts for the year included: (1) completion of the 1985-86 statewide low-altitude air photo flight, which can be used as an aid to mineral development; (2) updating topographic quadrangle map coverage through a cooperative agreement with the U.S. Geological Survey (USGS); (3) continued work on bedrock and surficial geological mapping and topical research; (4) gathering detailed information about the soils of the State to develop and disseminate information about the use of soils data for land use and land management; and (5) continued work, in cooperation with the USGS, on seismic data and submarine field investigations of unconsolidated deposits of Long Island Sound.<sup>5</sup> A number of reports concerning the State's geology and mineral resources were published or in preparation during the year.<sup>6</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Clays.**—In 1986, production and value increased 48% and 54%, respectively, the result of the continuing upsurge in construction activity. Two companies mined clays and shale for use in the manufacture of common and face brick. K-F Brick Co. mined Pleistocene glacial lake clay at its East Windsor Hill brickworks and also shale near Suffield, both in Hartford County. The Michael Kane Brick Co., the State's other producer, also mined glacial lake clay at an open pit in Middletown, Middlesex County. The clay deposits mined in the State are from the area known as the Central Lowlands.

**Feldspar.**—Connecticut ranked second of the six States that produced feldspar in 1986. The Feldspar Corp., in operation since the 1960's, operated three open pit quarries and a froth flotation plant in the old Middletown Pegmatite District in Portland and

Middletown, Middlesex County. The processed feldspar was shipped by truck to markets in New England, New Jersey, and New York and was used primarily by the glass and ceramics industries. It was added to glassmaking formulas to enhance the workability of molten glass and to improve the finished product by giving it better chemical stability by inhibiting any tendency toward divitrification. The feldspar in ceramic mixes was used principally as a flux.

In October, The Feldspar Corp. received a 2-year extension of its mining permit from the Middletown Planning and Zoning Commission. The company's 10-year permit to mine expired in 1983 and was never renewed. Although the company applied for a new 10-year permit and have operated uninterrupted since the permit expired, the commission only granted a 2-year agreement. Under its terms, The Feldspar Corp. must post a \$5,000 reclamation bond for every

acre it mines. In the next 2 years, it plans to mine about 22 acres and complete reclamation work on about 2.5 acres. The remaining acreage would be used for storage and other purposes.

**Gem Stones.**—A myriad of gem stones and minerals have been identified and collected in the State. One of the most popular gem collecting sites was in the Middletown Pegmatite District in the central part of the State. Several works have been published by CGNHS, the U.S. Bureau of Mines, and USGS, which give descriptions, locations, and qualities of the mineral species in the State.<sup>7</sup>

**Mica.**—The Feldspar Corp. continued to recover mica as a byproduct of the company's feldspar mining operations in Middletown, Middlesex County. The mica was marketed as a filler and as an additive in

well drilling mud.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel output and value was exceeded only by stone among the minerals produced in Connecticut. Production was reported in all eight counties in the State. Leading counties in order of output were Hartford, Windham, New London, and New Haven. Sand and gravel deposits typically occurred in major river valleys where they were formed as deltas of Pleistocene glacial lakes. Major uses were for construction and roadbuilding.

Table 4.—Connecticut: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand) -----	873	\$4,259	\$4.88
Plaster and gunite sands -----	43	193	4.49
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	104	456	4.39
Asphaltic concrete aggregates and other bituminous mixtures -----	365	788	2.16
Road base and coverings <sup>1</sup> -----	931	3,524	3.79
Fill -----	638	2,103	3.30
Snow and ice control -----	297	1,364	4.59
Other -----	316	1,875	5.93
Other unspecified <sup>2</sup> -----	3,686	11,424	3.10
Total <sup>3</sup> or average -----	7,254	25,984	3.58

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Connecticut was one of only three New England States that produced industrial sand. The two companies that operated during the year were The Feldspar Corp., which processed industrial sand as a byproduct of feldspar refining in Middletown in Middlesex County, and U.S. Silica Co. of Connecticut, which operated a quarry in New London County. Principal uses of industrial sand were in the manufacture of glass products, foundry molds and cores, and filtration. Both output and value are concealed because of proprietary data.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—The crushed stone industry

has been an important segment of the economy of Connecticut for many years. In 1986, crushed stone production accounted for nearly 57% of the State's mineral production value. Crushed stone production (predominantly Jurassic basalt commonly called traprock) increased nearly 6% compared with that of 1985. The basalt, a fine-grained, dark-colored igneous rock occurring chiefly as north-south ridges in the Central Lowlands, are predominant as belts of rocks in Hartford, Litchfield, and New Haven Counties. The largest quarries are operated primarily near the towns of Hartford and New Haven.

During the year, Tilcon Inc., the State's leading crushed stone producer, purchased Arthur Whitcomb Inc.'s 14 sand and gravel operations in New Hampshire and Vermont, which had annual sales of about \$30



million.

**Dimension.**—Dimension granite was quarried in New Haven County, and dimension granite and sandstone (quartzite) was quarried in Tolland and Windham Counties. Most of the stone was sold as irregular-shaped stone, rough blocks, and cut stone.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Geologist, State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Hartford, CT.

<sup>3</sup>Gately, M. Connecticut Construction Industry Performance Pacing the State Economy. ConnStruction, Mar. 1987, p. 35.

<sup>4</sup>Federal Reserve Bank of Boston. New England Economic Indicators. Third Quarter, 1986, pp. 14-15.

<sup>5</sup>Lewis, R. S., and S. W. Needell. Map Showing the Stratigraphic Framework and Quaternary Geologic History of Eastern Long Island Sound. USGS Misc. Field Studies Map MF-1939-A, 1987, 1:125,000 scale.

<sup>6</sup>Altamura, R. J., and S. S. Quarrier. Side-Looking Airborne Radar Lineament Mapping of Connecticut: A Progress Report. Geol. Soc. Am. Ab. and Prog., v. 18, No. 1, 1986, p. 2.

Altamura, R. J. The Snake Meadow Brook-Lantern Hill Fault Systems, An Echelon Brittle Fault Zone, Eastern Connecticut. Geol. Soc. Am. Ab. with Prog. v. 19, No. 1, 1987, p. 2.

Altamura, R. J. Bedrock Mines and Quarries of Connecticut. CT State Geol. and Nat. Hist. Surv. Nat. Resour. Atlas Ser. Map, scale 1:125,000, 1987.

<sup>7</sup>Sohon, J. A. Connecticut Minerals, Their Properties and Occurrence. CT State Geol. and Nat. Hist. Surv. Bull. 77, 1951, 128 pp.

Barton, W. R., and C. E. Goldsmith. New England Beryllium Investigations. BuMines RI 7070, 1968, 177 pp.

Stugard, F., Jr. Pegmatites of the Middletown Area of Connecticut. USGS Bull. 1042-Q, 1958, pp. 613-683.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
The Michael Kane Brick Co -----	654 Newfield St. Middletown, CT 06457	Pit and plant ----	Middlesex.
K-F Brick Co -----	Box 375 East Windsor Hill, CT 06028	Mine and plant --	Hartford.
<b>Feldspar:</b>			
The Feldspar Corp. <sup>1</sup> -----	Box 99 Spruce Pine, NC 28777	Mines and plant --	Middlesex.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Dan Beard Inc -----	Box 71, Mary St. Shelton, CT 06484	Pit and plant ----	New Haven.
Connecticut Sand & Stone Corp --	7 West Main St. Plainville, CT 06062	Pit and plants ---	Hartford and Litchfield.
D.B.D. Inc -----	Box 62 Brookfield, CT 06805	Pit and plant ----	Fairfield.
De Siato Sand & Gravel Corp ---	999 Stafford Rd. Storrs, CT 06268	Pit -----	Tolland.
R. A. Rawson Sand & Gravel Inc -	R.F.D. 1 Putnam, CT 06260	Pits and mill ----	Windham.
<b>Industrial:</b>			
U.S. Silica Co. of Connecticut ---	Box 577 Ottawa, IL 61350	Pit and plant ----	New London.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
Edward Balf Co -----	Box 11190 Newington, CT 06111	Quarry -----	Hartford.
O&G Industries Inc -----	23 Casson Ave. Box 907 Torrington, CT 06790	Quarries -----	Litchfield and New Haven.
Tilcon Tomasso Inc -----	Box 67 909 Foxen Rd. North Branford, CT 06471	Quarry -----	Hartford, New Haven, Windham.
York Hill Trap Rock Quarry Co --	Westfield Rd. Meriden, CT 06450	---do-----	New Haven.
<b>Dimension:</b>			
Box Mountain Quarries Inc ----	1111 Mott Hill Rd. South Glastonbury, CT 06073	---do-----	Tolland.
Castellucci & Sons Inc -----	West River St. Providence, RI 02904	---do-----	New Haven.
Wayne C. Williams General Construction Inc.	R.F.D. 1, Conklin Rd. Stafford Springs, CT 06076	---do-----	Tolland.

<sup>1</sup>Also crude mica and industrial sand.

# The Mineral Industry of Delaware

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

By L. J. Prosser, Jr.<sup>1</sup>

The value of Delaware's construction sand and gravel and greensand production in 1986 was about \$4.2 million. Value of magnesium compounds production was excluded from the State total to prevent disclosing company proprietary data.

**Legislation and Government Programs.**—The Delaware Geological Survey (DGS) continued cooperative programs relating to the geology and mineral resources of the State with the U.S. Bureau of Mines, U.S. Geological Survey, and Minerals Management Service. DGS publications in 1986 included one on the geology of south-central Kent County;<sup>2</sup> another on sodium concen-

trations in water from the Piney Point Formation;<sup>3</sup> and an evaluation of methods for locating underground storage tanks.<sup>4</sup>

The Center for Composite Materials at the University of Delaware received a \$1 million grant from ICI Americas Inc. for construction of a composite manufacturing laboratory.<sup>5</sup> Research at the facility was to focus on identifying manufacturing issues or problems that limit use of composites in industrial applications. A composite refers to the combination of a matrix, or binding material, through which a different reinforcing material is distributed; fiberglass was one of the first composite materials.

Table 1.—Nonfuel mineral production in Delaware<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones -----	--	--	--	--	NA	\$1
Marl (greensand) --- thousand short tons ---	1	\$18	2	\$29	1	12
Sand and gravel (construction) ---- do ----	1,003	2,795	1,300	4,000	1,547	4,156
Total <sup>2</sup> -----	XX	2,813	XX	4,029	XX	4,169

<sup>1</sup>Estimated. NA Not available. XX Not applicable.

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

<sup>3</sup>Partial total; excludes values that must be concealed to avoid disclosing company proprietary data.

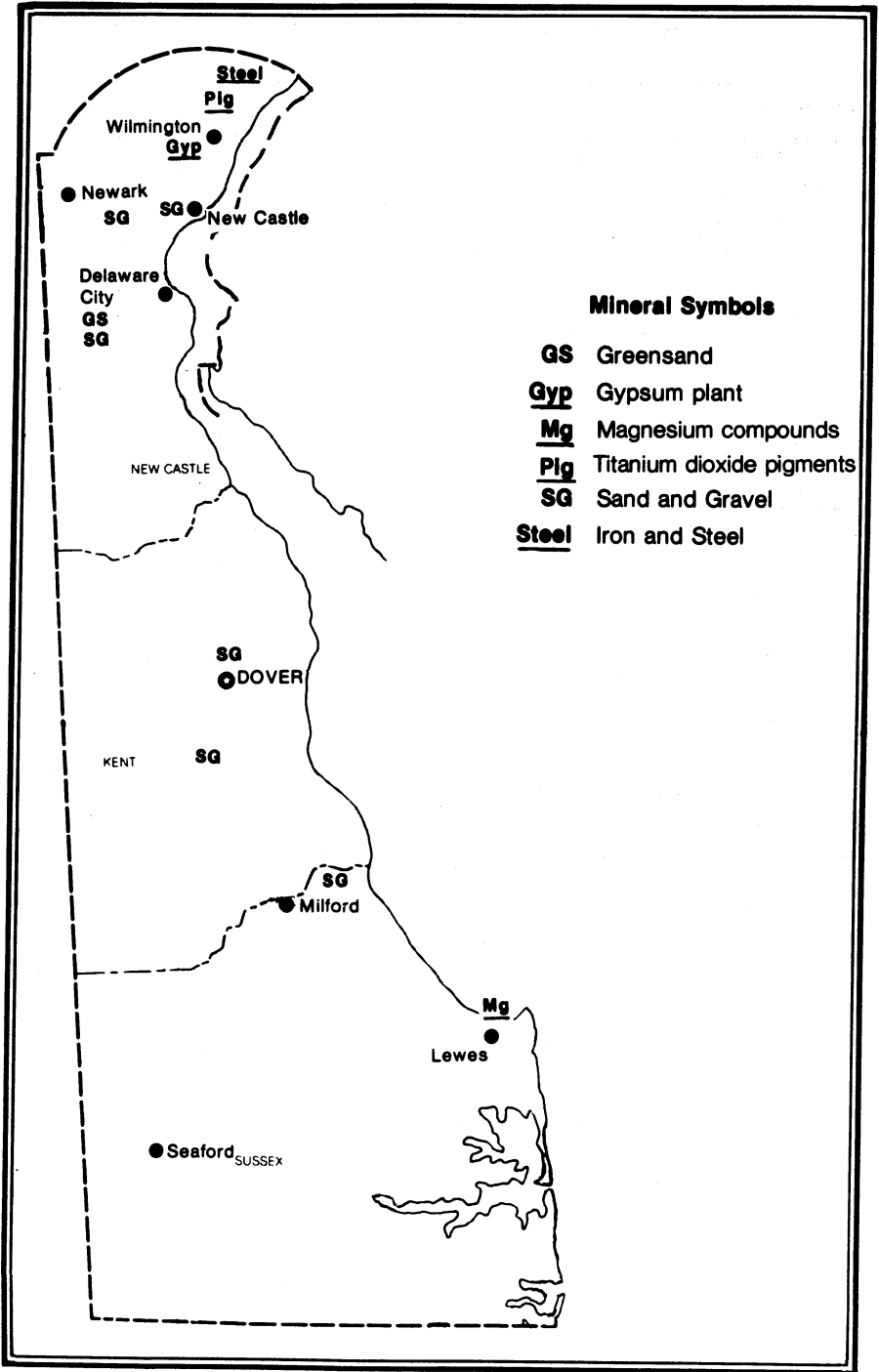


Figure 1.—Principal mineral-producing localities in Delaware.

Table 2.—Indicators of Delaware business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population ----- thousands .....	614	622	633
Total civilian labor force ----- do. ....	308	317	325
Unemployment ----- percent .....	6.2	5.3	4.3
<b>Employment (nonagricultural):</b>			
Mining total ----- thousands .....	0.1	0.1	0.1
Manufacturing total ----- do. ....	70.6	72.2	68.3
Primary metal industries ----- do. ....	1.8	1.8	1.6
Stone, clay, and glass products <sup>1</sup> ----- do. ....	.8	.8	.8
Chemicals and allied products ----- do. ....	31.9	31.7	30.9
Construction ----- do. ....	16.9	17.6	18.9
Transportation and public utilities ----- do. ....	11.9	12.0	12.5
Wholesale and retail trade ----- do. ....	61.9	64.4	67.8
Finance, insurance, real estate ----- do. ....	17.1	19.5	22.9
Services ----- do. ....	57.7	62.8	66.8
Government and government enterprises ----- do. ....	43.4	44.8	45.7
Total ----- do. ....	<sup>2</sup> 280.0	293.4	303.0
<b>Personal income:</b>			
Total ----- millions .....	\$8,253	\$8,901	\$9,498
Per capita -----	\$13,442	\$14,308	\$15,010
<b>Hours and earnings:</b>			
Total average weekly hours, production workers -----	41.5	41.1	41.2
Total average hourly earnings, production workers -----	\$9.3	\$9.9	\$10.1
<b>Earnings by industry:<sup>3</sup></b>			
Farm income ----- millions .....	\$142	\$124	\$119
Nonfarm ----- do. ....	\$6,542	\$7,075	\$7,414
Mining total ----- do. ....	\$22	\$32	\$30
Manufacturing total ----- do. ....	\$2,436	\$2,598	\$2,517
Stone, clay, and glass products ----- do. ....	\$21	\$17	\$18
Chemicals and allied products ----- do. ....	\$1,377	\$1,462	\$1,446
Petroleum and coal products ----- do. ....	\$67	\$66	\$43
Construction ----- do. ....	\$551	\$589	\$656
Transportation and public utilities ----- do. ....	\$341	\$344	\$391
Wholesale and retail trade ----- do. ....	\$848	\$902	\$983
Finance, insurance, real estate ----- do. ....	\$343	\$409	\$534
Services ----- do. ....	\$1,069	\$1,207	\$1,335
Government and government enterprises ----- do. ....	\$914	\$973	\$1,045
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> -----	4,364	4,636	5,527
Value of nonresidential construction <sup>4</sup> ----- millions .....	\$239.9	\$186.3	268.9
Value of State road contract awards <sup>5</sup> ----- do. ....	\$60.0	\$66.5	\$106.0
Shipments of portland and masonry cement to and within the State <sup>6</sup> ----- thousand short tons .....	175	204	236
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions .....	\$2.8	\$4.0	\$4.2
Value per capita -----	\$5	\$6	\$7

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

<sup>6</sup>Has no cement-producing plants.

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

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Delaware's small extractive minerals industry was supplemented with imports and shipments of raw materials from out-of-State sources primarily through the Port of Wilmington. American Minerals Inc. imported chrome and manganese ore for grinding at a plant near the Wilmington Marine Terminal, a part of the port com-

plex. Georgia-Pacific Corp. (G-P) also utilized the terminal as a site for its wallboard manufacturing plant using gypsum imported from Nova Scotia. E. I. du Pont de Nemours & Co. Inc. processed ilmenite for use as feedstock for manufacturing titanium dioxide pigments at its plant in Edgemoor. Texaco Inc., at its refinery in Delaware City, recovered elemental sulfur and produced sulfuric acid and petroleum coke

from crude oil imported from Mexico and Venezuela.

**Greensand.**—Delaware and New Jersey were the only two States in the Nation that produced greensand. Contractors Sand & Gravel Co. Inc. mined greensand near Middletown. Zook & Ranck Inc. purchased the raw material and processed it at Gap, PA, about 50 miles north of the minesite. Zook & Ranck sold the greensand primarily as a soil conditioner.

Nationally, the primary use of greensand remained as filter media for removal of manganese and iron from drinking water supply systems. Research by the DGS in the late 1970's showed another potential use. Results of that work, cosponsored by the Bureau of Mines, demonstrated that greensands have the capacity to remove many heavy metals from landfill leachate.<sup>6</sup>

**Magnesium Compounds.**—Barcroft Co., a subsidiary of Rorer Group Inc., produced

magnesium hydroxide from seawater near Lewes. Pharmaceutical-grade magnesium hydroxide was used in antacids, laxatives, and specialty products. Output in 1986 remained about the same as in 1985, a typical pattern for commodities with a stable end product market.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

In line with the gains recorded in the construction activity section of table 2, construction sand and gravel production increased to 1.5 million short tons, the highest total since 1979. In 1986, eight companies operating eight pits reported production.

Table 3.—Delaware: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	152	\$543	\$3.57
Plaster and guniting sands -----	W	W	4.88
Road base and coverings -----	W	W	2.43
Fill -----	388	777	2.00
Other unspecified <sup>1</sup> -----	1,008	2,835	2.81
Total <sup>2</sup> or average -----	1,547	4,156	2.69

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

<sup>1</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

Delaware's construction industry also purchased an estimated 1.5 million tons of construction aggregate from producers in Maryland, New Jersey, and Pennsylvania.<sup>7</sup> One such operation using out-of-State materials was Wilmington Materials Inc., which opened a 150,000-ton-per-year asphalt plant in Dover. The construction firm, along with four others, invested \$1 million for state-of-the-art technology and equipment.<sup>8</sup> Raw materials included crushed stone purchased from a producer in Pennsylvania and sand bought from a New Jersey operator.

### METALS

Guardian Ventures, the majority owner of the State's sole steel producer, Phoenix

Steel Corp., put the firm up for sale in November, offering it as a whole, in parts, or for equipment and machinery. In December, the melt shop was idled when the scrap inventory was depleted. These two actions were caused by debt reorganization and cash flow problems. A complete shutdown of the Phoenix operations in Claymont would cost the Delaware economy an estimated \$60 million annually and about 750 jobs.<sup>9</sup> Also, International Mill Service Inc., which processed steel slag, a byproduct of the Phoenix operation, was expected to close if the steelmaker shut down. Slag was sold to the construction industry for use as road base material.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Benson, R. N., and T. E. Pickett. Geology of South-Central Kent County Area, Delaware. DE Geol. Surv. Geol. Map Ser., No. 7, 1986, scale 1:24,000.

<sup>3</sup>Spoljaric, N. Sodium Concentrations in Water From the Piney Point Formation, Dover Area, Delaware. DE Geol. Surv. Rep. of Inv. No. 40, 1986, 14 pp.

<sup>4</sup>Andres, A. S. Evaluation of Remote Sensing and Surface Geophysical Methods for Locating Underground Storage Tanks. DE Geol. Surv. Open File Rep. No. 30, 1986, 8 pp.

<sup>5</sup>American Metal Market. University of Delaware Composites Grant. V. 94, No. 179, Sept. 15, 1986, p. 12.

<sup>6</sup>Spoljaric, N., and W. A. Crawford. Removal of Metals From Laboratory Solutions and Landfill Leachate by Greensand Filters. DE Geol. Surv. Rep. of Inv. No. 32, 1979, 30 pp.

<sup>7</sup>First State Geology. Delaware Mineral Production. V. 5, No. 2, summer 1987, p. 3.

<sup>8</sup>Milford, M. Asphalt is no Longer a Stone Age Business. Morning News (Wilmington), Sept. 17, 1987, p. 18.

<sup>9</sup>Wallick, M. Workers, State Will Feel Pinch if Phoenix Folds. Sunday News J. (Wilmington), Dec. 21, 1986, p. 3.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Greensand:</b>			
Contractors Sand & Gravel Co. Inc. <sup>1</sup> ---	Box 2630 Wilmington, DE 19805	Pit-----	New Castle.
<b>Gypsum (calcined):</b>			
Georgia-Pacific Corp., Gypsum Div ---	Wilmington Marine Terminal Box 310 Wilmington, DE 19899	Plant -----	Do.
<b>Magnesium compounds:</b>			
Barcroft Co -----	40 Cape Henlopen Dr. Lewes, DE 19958	Plant (pharmaceutical-fine chemical).	Sussex.
<b>Sand and gravel (construction):</b>			
Dover Equipment & Machine Co. ----	113 West 6th St. New Castle, DE 19720	Dredge -----	Kent.
Parkway Gravel Inc -----	4048 New Castle Ave. New Castle, DE 19720	Pit-----	New Castle.
Howard L. Ritter & Sons -----	Box 716 Lewes, DE 19958	Pit-----	Sussex.
Staytons Sand & Gravel Inc -----	Box P Felton, DE 19943	Pit-----	Kent.
<b>Slag—steel:</b>			
International Mill Service Inc -----	Philadelphia Pike Box 160 Claymont, DE 19703	Plant (processing).	Do.
<b>Steel:</b>			
Phoenix Steel Corp -----	4001 Philadelphia Pike Claymont, DE 19703	Mill (plate)---	Do.
<b>Sulfur (recovered):</b>			
Texaco Inc -----	Wrangle Hill Rd. Delaware City, DE 19706	Refinery (petroleum).	Do.
<b>Titanium dioxide:</b>			
E. I. du Pont de Nemours & Co. Inc ---	1007 Market St. Wilmington, DE 19898	Corporate headquarters.	Do.
Do -----	Edgemoor, DE 19809 -----	Plant (chemical).	Do.

<sup>1</sup>Also sand and gravel.



# The Mineral Industry of Florida

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

By James R. Boyle<sup>1</sup> and Charles W. Hendry, Jr.<sup>2</sup>

In 1986, the value of nonfuel mineral production in Florida was \$1.3 billion, a decrease of \$267 million from that of 1985. This was the first decrease in 4 years and was directly attributed to the decrease in phosphate rock output; nearly all other nonfuel minerals increased or remained stable in output. The State ranked fourth in the Nation in output of nonfuel minerals, with industrial minerals accounting for nearly all of the value. Principal industrial minerals, in order of value, were phosphate rock, crushed stone, portland cement, con-

struction sand and gravel, and clays. Florida ranked first in the production of peat and phosphate rock, second in crushed stone and fuller's earth, third in masonry cement, seventh in construction sand and gravel, and eighth in portland cement. Ilmenite, rutile, staurolite, and zircon concentrates were produced only in the State, as products of mineral sands operations.

Florida remained the predominant producer of phosphate rock nationally, and along with North Carolina supplied nearly 90% of the domestic phosphate rock output.

Table 1.—Nonfuel mineral production in Florida<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons ..	383	\$24,624	316	\$17,137	352	\$21,269
Portland ----- do. ....	3,564	172,548	3,282	148,908	3,189	147,643
Clays ----- do. ....	772	34,048	672	33,074	726	43,261
Gem stones ----- do. ....	NA	*6	NA	*6	NA	W
Lime ----- thousand short tons ..	171	9,379	W	W	W	W
Peat ----- do. ....	263	5,454	243	5,333	365	5,743
Sand and gravel:						
Construction ----- do. ....	21,032	48,494	*22,500	*49,500	28,233	67,898
Industrial ----- do. ....	1,533	9,815	2,123	12,642	1,467	14,930
Stone (crushed) ----- do. ....	*68,500	*290,000	69,266	287,237	*69,000	*288,200
Combined value of magnesium compounds (1984), phosphate rock, rare-earth metal concentrates, staurolite, titanium concentrates, zircon concentrates, and values indicated by symbol W -----	XX	915,996	XX	*1,007,899	XX	706,209
Total -----	XX	1,510,364	XX	*1,561,736	XX	1,295,153

\*Estimated.   <sup>†</sup>Revised.   NA Not available.   W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure.   XX Not applicable.

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



**Table 2.—Nonfuel minerals produced in Florida in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Alachua -----	Stone (crushed).
Brevard -----	Clays, stone (crushed).
Broward -----	Stone (crushed).
Charlotte -----	Do.
Citrus -----	Do.
Clay -----	Titanium concentrates, zircon concentrates, staurolite, clays, monazite, peat.
Collier -----	Stone (crushed).
Dade -----	Stone (crushed), cement.
Escambia -----	Sand (industrial).
Gadsden -----	Clays.
Glades -----	Sand (industrial).
Hamilton -----	Phosphate rock.
Hardee -----	Do.
Hendry -----	Stone (crushed).
Hernando -----	Stone (crushed), cement, lime, clays.
Hillsborough -----	Phosphate rock, cement, stone (crushed), peat.
Jackson -----	Stone (crushed).
Lake -----	Peat, sand (industrial), clays.
Lee -----	Stone (crushed).
Levy -----	Do.
Madison -----	Peat.
Manatee -----	Phosphate rock, cement.
Marion -----	Stone (crushed), clays, sand (industrial).
Monroe -----	Stone (crushed).
Palm Beach -----	Peat, stone (crushed).
Pasco -----	Stone (crushed), peat.
Polk -----	Phosphate rock, sand (industrial), stone (crushed), peat.
Putnam -----	Sand (industrial), clays, peat.
St. Lucie -----	Stone (crushed).
Sarasota -----	Do.
Sumter -----	Stone (crushed), lime, peat.
Suwannee -----	Stone (crushed).
Taylor -----	Do.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Table 3.—Indicators of Florida business activity**

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	11,046	11,364	11,675
Total civilian labor force -----	do	5,140	5,344	5,588
Unemployment -----	percent	6.3	6.0	5.7
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	10.2	10.1	9.5
Nonmetallic minerals except fuels -----	do	8.7	8.7	8.2
Oil and gas extraction <sup>1</sup> -----	do	1.1	1.0	.8
Manufacturing total -----	do	501.8	514.4	516.9
Primary metal industries -----	do	5.2	5.2	5.2
Stone, clay, and glass products -----	do	24.0	23.8	24.7
Chemicals and allied products -----	do	26.4	25.9	24.2
Petroleum and coal products -----	do	1.8	1.9	2.0
Construction -----	do	318.4	334.3	339.7
Transportation and public utilities -----	do	241.1	243.0	245.0
Wholesale and retail trade -----	do	1,121.4	1,184.8	1,239.3
Finance, insurance, real estate -----	do	299.2	319.2	339.6
Services -----	do	1,065.9	1,129.8	1,202.6
Government and government enterprises -----	do	650.7	674.4	697.0
<b>Total</b> -----	do	4,208.7	4,410.0	4,589.6
<b>Personal income:</b>				
Total -----	millions	\$143,962	\$157,924	\$170,980
Per capita -----	do	\$13,033	\$13,897	\$14,646

See footnotes at end of table.

Table 3.—Indicators of Florida business activity —Continued

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	41.2	41.3	40.8	
Mining (nonmetallic minerals)	48.0	47.2	44.4	
Total average hourly earnings, production workers	\$7.6	\$7.9	\$8.0	
Mining (nonmetallic minerals)	\$8.3	\$8.5	\$8.7	
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$2,022	\$2,100	\$2,279
Nonfarm		\$87,679	\$95,506	\$105,199
Mining total	do	\$628	\$842	\$833
Metal mining	do	\$12	\$14	\$14
Nonmetallic minerals except fuels	do	\$224	\$225	\$212
Oil and gas extraction	do	\$387	\$598	\$602
Manufacturing total	do	\$11,148	\$12,015	\$12,699
Primary metal industries	do	\$128	\$131	\$136
Stone, clay, and glass products	do	\$539	\$554	\$603
Chemicals and allied products	do	\$756	\$777	\$767
Petroleum and coal products	do	\$52	\$55	\$63
Construction	do	\$7,508	\$8,152	\$8,743
Transportation and public utilities	do	\$7,021	\$7,410	\$7,730
Wholesale and retail trade	do	\$16,878	\$18,661	\$20,167
Finance, insurance, real estate	do	\$6,336	\$7,222	\$8,695
Services	do	\$23,019	\$25,635	\$28,399
Government and government enterprises	do	\$14,345	\$15,679	\$16,962
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup>		205,047	202,615	195,525
Value of nonresidential construction <sup>3</sup>	millions	\$4,823.4	\$6,083.9	\$5,045.0
Value of State road contract awards <sup>4</sup>	do	\$788.0	\$788.0	\$910.0
Shipments of portland and masonry cement to and within the State	thousand short tons	6,733	6,608	6,859
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$1,510.4	\$1,561.7	\$1,295.2
Value per capita		\$137	\$137	\$111

<sup>p</sup>Preliminary. <sup>f</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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 State's economic structure was dominated by trade, service, and construction; construction activities were major users of mineral aggregates. Florida's economy continued its better than average rate of growth through 1986, with construction increasing slightly; past overbuilding prevented a larger increase in this sector.<sup>3</sup> The State remained one of the fastest growing in the Southeast, resulting in sustained high levels of output from the State's construction aggregate operations.

The Port of Tampa handled over 44 million short tons of cargo in the fiscal year ending September 30, 1986, down from nearly 49 million short tons from the previous fiscal year. Export shipments continued to be sluggish as demand for phosphate and fertilizers dropped. Exports included bulk phosphate rock (8,091,867 short tons), bulk phosphate chemicals (3,192,869 short tons), and phosphoric acid (322,387 short tons), all decreases from the previous fiscal year. The

port also handled over 3 million short tons of sulfur (liquid), nearly 500,000 tons of which was imported; the balance came from domestic sources. Despite Florida being a major producer of crushed stone, the port imported granite (158,070 short tons) and limestone (46,157 short tons). Other imports included anhydrous ammonia, cement, clinker, gypsum, potash, salt, and slag.

Total oil and gas production in Florida declined for the eighth straight year. Oil production dropped from 11.5 million barrels in 1985 to 9.4 million barrels; gas production dropped from 11.7 billion cubic feet to 9.8 billion cubic feet.

**Employment.**—Florida's 1986 unemployment rate was 5.7%, down from 6.0% in 1985. Average annual employment in the mining industry was about 9,600, down from 10,100 in 1985. Nearly all of the decrease was experienced in phosphate mining as its employment fell from about 4,900 in 1985 to 4,300. Construction employment increased about 4,400, or only about 1%.

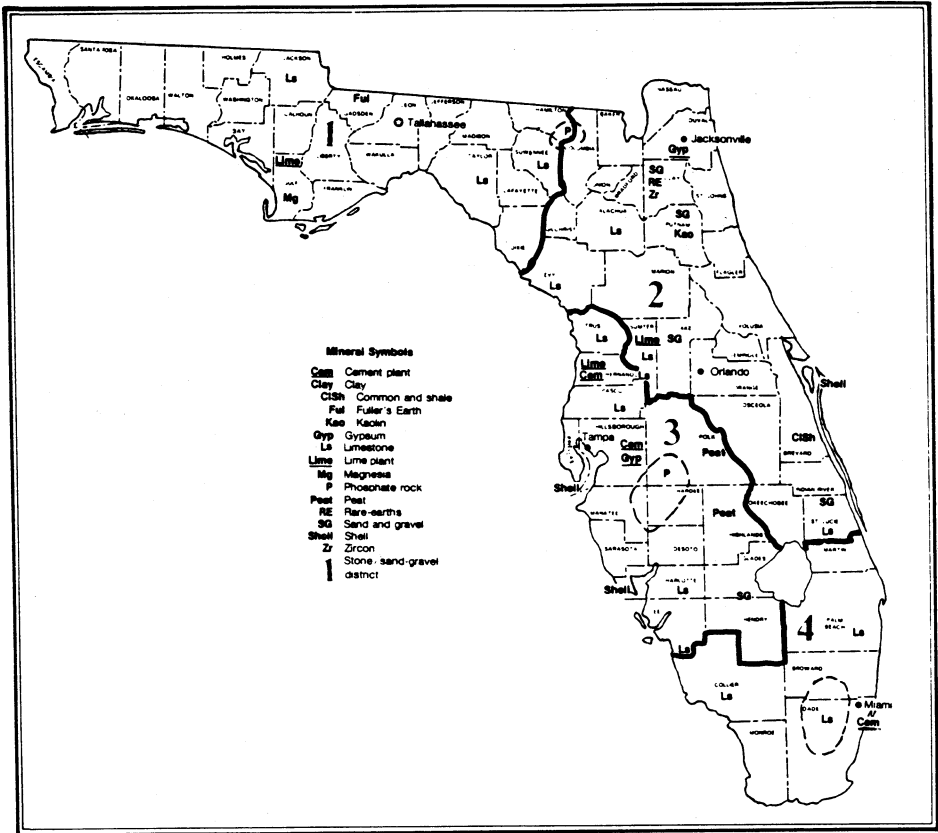


Figure 1.—Principal mineral-producing localities in Florida.

**Legislation and Government Programs.**—The Florida Legislature enacted two bills affecting the mineral industry; one imposed an excise tax on oil, gas, and sulfur, and the other pertained to reclamation of mined lands. The Reclamation Act enabled the Department of Natural Resources to develop criteria and standards for phosphate mine reclamation and to establish a schedule for completion of reclamation. The act also provided powers to the department with respect to reclamation of lands disturbed by extraction of other resources. Specifically mentioned were limestone, heavy minerals, and fuller's earth. During the year, the Department of Natural Resources Bureau of Mine Reclamation developed rules covering mandatory phosphate mine reclamation (chapter 16C-16), certification to administer reclamation rules

(chapter 16C-35), heavy mineral reclamation requirements (chapter 16C-37), and fuller's earth reclamation requirements (chapter 16C-38).

The Florida Bureau of Geology continued its geologic investigations in the State, which included studies of both nonfuel and fuel resources. The Geologic Investigations Section completed for publication notes on the geology of three counties, a report on Florida Karst, a report on industrial minerals of Florida, heavy mineral reconnaissance, and an overview of peat. Projects under way included a geologic map of Florida, geology of eight counties, and stratigraphy of Florida. The Mineral Resources Investigation and Environmental Geology Section compiled a Florida mineral producers directory and a summary of parameters to be assessed for hazardous waste disposal. Eleven publications were issued during the year.

The Florida Institute of Phosphate Research continued its funding of research activities with respect to mining and processing phosphate rock and reclamation of disturbed lands. Funding was received from severance taxes on phosphate and was directed toward chemical processing, beneficiation, reclamation, mining, and environmental studies. Utilization of phosphogypsum, a byproduct of fertilizer production, remains a top priority for research. Publications issued during the year included "Evaluation of Phosphatic Clay Disposal and Reclamation Methods," "Measurement of Recovery in Lakes Following Phosphate Mining," "Radioactivity in Food Grown on Florida Phosphate Lands," and "Environmental Contaminants in Birds: Phosphate Mine and Natural Wetlands."

The Florida Department of Revenue reported receipts of severance taxes during fiscal year 1986 for solid minerals of \$94.4 million, up from \$84.0 million in 1985. Severance taxes from oil and gas totaled

\$17.4 million, down from \$21.6 million in 1985.

The issue of offshore oil and gas revenue from Federal leases to be shared with Florida and other coastal States under section 8(g) of the Outer Continental Shelf Land Acts of 1978 was settled early in 1986. Legislation was signed giving coastal States 27% of all revenue earned in the zone adjacent to their borders from September 1978 to October 1986. Florida's share for this period totaled \$30,000.

Since 1972, the U.S. Bureau of Mines Tuscaloosa (AL) Research Center has conducted research projects on phosphate mining and beneficiation, including, in 1986, recovery of phosphate using leaching techniques, dewatering phosphate slurries, and recovery of sulfur from phosphogypsum waste. Report of Investigation 9016, "Large-Scale Dewatering of Phosphatic Clay Waste From Polk County, FL," was released during the year.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Shipments of masonry cement increased while those of portland cement decreased slightly compared with those of 1985. Cement remained the third leading commodity by value in Florida. Output of masonry cement ranked third nationally, while that of portland cement ranked eighth. Continued high levels of construction activity kept output of cement at a relatively high level. Although demand was strong, weak prices remained a problem with the cement industry. Five companies produced portland cement at five plants; masonry cement was produced at four plants. Florida continued to import both cement and clinker; cement through Miami and Tampa and clinker only through Tampa. Cement imports totaled nearly 2.5 million short tons compared with 3.2 million tons in 1985, nearly two-thirds through Tampa. Clinker imports increased from 483,000 tons in 1985 to 960,000 tons in 1986. The major portion of cement imports was from Mexico, Spain, and Venezuela. Imports of clinker came mainly from Mexico and Spain.

Shipments of portland cement were mainly in bulk form by truck and rail. Major consumers were ready-mixed concrete, building material dealers, and concrete product manufacturers. Raw material

from within the State used to manufacture cement included clays, fly ash, limestone, sand, and staurolite. Gypsum and iron ore from out of State were also utilized. Seven rotary kilns were operated at the five plants; five were wet process and two were dry process. Energy requirements in the manufacture of cement included 379 million kilowatt hours of electric energy, down from 386 million kilowatt hours in 1985. Additional energy utilized included coal, fuel oil, and natural gas.

Florida Crushed Stone Co. continued construction of its 600,000-short-ton-per-year cement plant at Brooksville. The facilities, including a 125-megawatt cogeneration unit and a 350,000-ton-per-year lime plant, were scheduled to be completed by mid-1987.

**Clays.**—Clays produced in Florida included common clay, fuller's earth, and kaolin. Total clay output increased over 50,000 short tons, while value increased over \$10 million. Output and value of common clay decreased from that of 1985. Three companies produced common clay at three pits in Clay, Hernando, and Lake Counties. Common clay was used in the manufacture of cement and lightweight aggregates. Fuller's earth was mined by four companies at four pits in Brevard, Gadsden, and Marion Counties. Florida ranked second nationally in output of fuller's earth; output and value

increased over that of 1985. Material mined was mainly an attapulgite product, with output shipped nationwide. The material was dried, ground, and screened prior to shipment. Basic end uses were pet waste absorbents and oil and grease absorbents, in fertilizers, pesticides, and as gelling clays in saltwater drilling muds.

One company produced kaolin in Putnam County; output and value remained about the same as in 1985. The kaolin was used where a high degree of workability was required, such as jiggering and extrusion processes; the material was also used in glazes. Main uses were electrical porcelain, whiteware, and wall tile. Byproduct industrial sand was also recovered at the operation and used primarily for glassmaking.

**Fluorspar.**—Fluosilicic acid was recovered as a byproduct of wet-process phosphoric acid manufacture. Six companies operated facilities in Florida. Fluosilicic acid was used to produce aluminum fluoride, cryolite, fluoride, sodium silica fluoride, and was used in water fluoridation.

**Gypsum.**—Imported gypsum was calcined by three companies at two plants in Duval County and one in Hillsborough County. USG Corp., Jim Walter Corp., and National Gypsum Co. calcined gypsum prior to wallboard manufacture. Florida ranked third nationally in output of wallboard, with USG's plant ranking as the Nation's largest individual plant. Output increased while value decreased. Byproduct gypsum was recovered by Occidental Chemical Co. at its White Springs facility. Output and value decreased from that of 1985.

**Lime.**—Florida produced only quicklime, with output decreasing. Quicklime was produced by Dixie Lime & Stone Co., Sumter County, and was used in water purification and paper and pulp manufacturing.

**Nitrogen.**—Anhydrous ammonia was produced by Air Products & Chemicals Inc. at its facility in Pace Junction; capacity was 100,000 short tons per year. The Directory of Florida Industries also listed Jones Chemical Inc., Fort Lauderdale, as having

anhydrous ammonia in its product line. Nitram Inc. produced nitric acid at its facility in Tampa.

**Peat.**—Florida ranked first nationally in peat sales, with output and value increasing. Reed-sedge and humus peat production was reported by 15 operations from 8 counties. The major portion of peat was shipped by bulk for use as a potting soil and in nurseries.

**Perlite (Expanded).**—Four companies expanded perlite from crude ore shipped into the State. Production and value increased slightly from that of 1985. Perlite was expanded at plants in Broward, Duval, Escambia, and Indian River Counties. Principal uses were construction aggregate, filler, horticultural purposes, and insulation.

**Phosphate Rock.**—Florida ranked first in the Nation in output of phosphate rock, and the industry remained the predominant mineral industry in the State. After 3 years of steadily increased output, production in 1986 dropped over 25% with value dropping nearly one-third. The problem was twofold: Domestic demand declined with Federal acreage reduction programs that reduced phosphate fertilizer consumption, and foreign competition and weak demand reduced fertilizer exports. Most operations produced at reduced levels of output; the Department of Revenue estimated output at 32.5 million metric tons, while the Florida Phosphate Council estimated output at 29.7 million metric tons. Employment in the industry dropped to about 10,500, compared with 1980 when 14,600 were employed. During the year some producers sold below cost to reduce inventories and maintain cash-flow. Prices for some products were at the lowest levels in a decade.

Several small companies recovered about 45,000 tons of soft phosphate rock from hard-rock phosphate mine tailings ponds in north-central Florida. Land-pebble phosphate was produced by 12 companies at 21 mines in Hamilton, Hardee, Hillsborough, Manatee, and Polk Counties, as shown in the following tabulation:

Company	Mines	Status	Production	Exports
Agrico Chemical Co.-----	Fort Green-----	Operated-----	Decreased--	Yes.
	Payne Creek-----	Closed early in year		
	Saddle Creek-----	Closed late in year		
	Big Four-----	Sold to FCS; sold to Mobil.	None-----	No.
Beker Phosphate Corp----- Brewster Phosphates-----	Wingate Creek-----	Operated-----	Decreased--	No.
	Haynsworth-----	Leased to IMC--operated.	----do----	Yes.
	Lonesome-----	Leased to IMC--closed.		
CF Industries Inc----- Estech Inc-----	Hardee Complex No. 1-----	Operated-----	----do----	No.
	Silver City-----	Closed; reopen in 1987.	Increased--	Yes.
	Watson-----	Operated-----		
Gardiner Inc----- W. R. Grace & Co-----	Fort Meade-----	Operated-----	Decreased--	No.
	Four Corners-----	Closed early in year		
Hopewell Land Corp----- International Minerals & Chemical Corp.	Hooker Prairie-----	Operated-----	----do----	Yes.
	Lithia-----	Closed at midyear--	Increased--	Yes.
	Clear Springs-----	Operated; closed periodically.	----do----	Yes.
	Kingsford-----	----do----		
Mobil Mining and Minerals Co.	Noraly-n-Phosphoria-----	----do----		
	Fort Meade-----	Operated-----	Decreased--	Yes.
Occidental Chemical Co--	Nichols-----	Closed at midyear--		
	Suwanee River-----	Operated-----	Increased--	Yes.
	Swift Creek-----	----do----		
USS Agri-Chemicals Inc--	Rockland-----	----do----	Increased--	No.

Agrico Chemical Co.'s mines experienced short work weeks and a summer shutdown. The Saddle Creek Mine was closed in December, with plans to reopen the Payne Creek Mine early in 1987. Agrico acquired 14,150 acres of phosphate reserves from U.S. Diversified Group of USX Corp.; the reserves will reportedly lengthen the life of the Fort Green Mine by about 12 years. Late in the year, the Williams Companies made a tentative agreement to sell Agrico to Freeport-McMoRan Resources Partners Ltd. for \$250 million plus deferred payments depending on Agrico's performance.

AMAX Chemical Inc. completed the sale of its Florida holdings to FCS Energy Inc. for over \$40 million. The assets included the Piney Point phosphoric acid plant, the Big Four Mine, the Pine Level Deposit, and the Plant City plant; the company will operate as Consolidated Minerals Inc. Late in the year FCS sold the Big Four Mine to Mobil Mining and Minerals Co.

Beker Phosphate Corp. trucked ore to Port Manatee and then barged the material to its fertilizer plant at Taft, LA. Beker operated under chapter 11 of the Federal Bankruptcy Code and sold 4,000 acres of land to Manatee County for \$11.2 million.

Brewster Phosphates leased its mines to International Minerals & Chemical Corp. (IMC) in October. IMC subsequently closed both mines but reopened the Haynsworth Mine shortly thereafter. Brewster sold its reserves to IMC.

CF Industries Inc. reduced its level of operations late in the year to one shift per day and purchased ore from IMC. CF's plant at Plant City was reduced to 60% of capacity in November and then to 25% by year-end. The Bartow plant remained closed.

Estech Inc. completed the sale of 10,500 acres of land to Manatee County for \$26 million. Manatee County purchased the property to protect the Manatee River watershed, which supplies Manatee and Sarasota Counties with drinking water.

Farmland Industries Inc. operated its Green Bay fertilizer plant at reduced levels for part of the year. The plant was closed at the end of January and reopened in September.

Cargill Inc. purchased 80% of Gardiner Inc. in January and reopened the mine and plant in March; the facilities operated at about 70% of capacity.

W. R. Grace & Co.'s Four Corners Mine, a joint venture with IMC, closed in March for at least 2 years. The Four Corners Mine had been operating only since early 1985. W. R. Grace reportedly was seeking a buyer for its phosphate fertilizer assets.

IMC's mines were closed in January and also for a 6-week period during the year because of high inventories. Late in the year, IMC leased the Haynsworth and Lonesome Mines from Brewster and closed both operations; the Haynsworth Mine was subsequently reopened. IMC also acquired Brewster's phosphate reserves in the area.

Occidental operated its facilities at various levels of capacity during the year. Occidental exported superphosphoric acid through the Jacksonville Bulk Terminal to the U.S.S.R.

Royster Co., a subsidiary of Superfos N/A, operated its Mulberry plant at less than capacity during the year. Superfos reportedly was seeking a buyer for the facility. If no buyer was found, a complete shutdown in 1987 was possible.

USS Agri-Chemicals Inc. operated plants at Fort Meade and Bartow. USS Agri-Chemicals sold 14,150 acres of reserves to Agricore during the year.

**Sand and Gravel.**—Florida produced both construction and industrial sand and gravel. Production was from 36 companies at 55 operations in 19 counties. Total output increased and reached a record-high level for total sand and gravel production.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years

only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the fourth leading commodity in value among the nonfuel minerals produced in Florida. The increase was basically because of the continued surge in all construction sectors during the year. Florida ranked seventh nationally in output of construction sand and gravel. During 1986, 30 companies produced from 47 operations in 19 counties; leading counties were Lake, Polk, and St. Lucie. Transportation was mainly by truck, and principal uses were concrete aggregates and fill. Six companies produced over 1 million short tons each.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 5 presents end-use data for construction sand and gravel production in the four districts depicted in figure 1.

**Table 4.—Florida: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	10,311	\$30,858	\$2.99
Plaster and gunitite sands -----	1,176	3,821	3.25
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	1,048	2,928	2.79
Asphaltic concrete aggregates and other bituminous mixtures -----	1,008	3,381	3.35
Road base and coverings -----	W	W	1.00
Fill -----	6,234	6,883	1.10
Other -----	308	802	2.60
Other unspecified <sup>1</sup> -----	8,148	19,224	2.36
Total or average -----	28,233	\$67,898	2.40

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

<sup>1</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Table 5.—Florida: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	700	2,333	5,316	15,984	1,897	4,800	177	768
Asphaltic concrete aggregates and other bituminous mixtures -----	W	W	343	770	W	W	--	--
Road base and coverings <sup>2</sup> -----	W	W	--	--	W	W	--	--
Fill -----	71	131	3,716	3,846	744	928	1,663	1,938
Other unspecified <sup>3</sup> -----	1,296	4,375	3,771	8,724	3,661	8,316	57	181
Total <sup>4 5</sup> -----	2,066	6,839	13,146	29,324	6,302	14,044	1,898	2,887

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

<sup>1</sup>Includes plaster and gunitite sands, and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement).

<sup>3</sup>Includes other specified uses, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Excludes 4,821,000 short tons valued at \$14,804,000 not reported by county.

<sup>5</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Six companies produced industrial sand, one as a byproduct of kaolin operations. Output decreased while unit values increased. Industrial sand was used in glass manufacture and for foundry sands with markets for both uses in Alabama, Florida, Georgia, and Tennessee.

**Staurolite.**—Florida was the only State with a recorded production of staurolite, an iron-aluminum silicate, which was recovered as a coproduct of heavy-mineral processing in Clay County by E. I. du Pont de Nemours & Co. Inc. Production increased over that of 1985, while unit values decreased. Staurolite was used mainly in foundry applications, for sandblasting, and in cement manufacture where it was used as a fluxing agent.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone ranked second in mineral value in Florida, with output estimated to have remained at about the same level as that of 1985. Continued high levels of construction activity maintained the high output of crushed stone—the highest level ever recorded in the State. Florida ranked second in the Nation in crushed stone production in 1985, and estimates indicate the State retained that ranking in 1986. Florida produced dolomite, limestone, marl, and oyster shell. Crushed stone was used mainly for concrete and bituminous aggregates, cement manufacture, and dense-graded road base. Despite the record-high output of crushed stone, 123,000 short tons of slag and 46,000 short tons of limestone were imported through the Port of Tampa.

**Sulfur (Recovered).**—Output from Exxon Corp.'s natural desulfurization plant in Santa Rosa County decreased for the eighth straight year, as oil and gas production continued to decrease. The State ranked 12th nationally in the recovery of byproduct elemental sulfur; unit prices increased.

**Vermiculite (Exfoliated).**—Exfoliated vermiculite was produced by two companies at four plants in Broward, Duval, and Hillsborough Counties. Crude ore was shipped in from out of State. Florida ranked

third nationally in output. Principal uses were for concrete aggregate, horticulture, and insulation.

## METALS

**Iron and Steel.**—Florida Steel Corp., 1 of the top 15 steelmakers in the Nation with a capacity of nearly 1.6 million short tons of bar and rod annually, operated minimills at Jacksonville and Tampa; their Indiantown facility remained shut down. During the year, the company converted an electric arc furnace at Tampa to a direct-current operation. The conversion would not only save in energy costs, but it would reduce usage of electrodes by one-half.

According to the Directory of Florida Industries, 29 aluminum foundries, 18 brass-copper foundries, 14 gray iron foundries, and 13 steel foundries operated in the State. The majority of these foundries were relatively small.

**Mineral Sands.—Rare-Earth Minerals.**—Florida remained the only State with recovery of rare earths from mineral sands mining. Associated Minerals recovered monazite concentrate as a byproduct of its operation in Clay County. Output decreased while unit prices remained stable.

**Titanium Concentrates.**—DuPont and Associated Minerals produced concentrates from their heavy-mineral operations in Clay County. Rutile shipments increased over those of 1985, while ilmenite shipments decreased. Unit prices of both increased. This is the seventh straight year of increased output of rutile concentrates and the first decrease in output of ilmenite concentrates since 1981. Florida was the only State in which rutile and ilmenite were produced.

**Zircon.**—DuPont and Associated Minerals recovered zircon concentrate from their operations in Clay County. Output increased along with unit values; production was at its highest level in over 10 years. Florida remained the only State with a recorded production of zircon, a byproduct of mineral sands operations. Principal markets were in the ceramic, foundry, and refractory industries.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>State geologist, Florida Bureau of Geology, Tallahassee, FL.

<sup>3</sup>Federal Reserve Bank of Atlanta. Economic Review. Nov.-Dec. 1986. pp. 15-16.



Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
General Portland Inc.-----	Box 22348 Tampa, FL 3362	Plants-----	Hillsborough.
Lonestar Florida Pennsuco Inc	Box 122035 Hialeah, FL 33012	Plant-----	Dade.
Moore McCormack Resources Inc.	Box 23965 Tampa, FL 33630	----do-----	Hernando.
National Portland Cement Co	Route 1 Port Manatee, FL 33561	----do-----	Manatee.
Rinker Portland Cement Corp	Drawer K Palm Beach, FL 33402	----do-----	Dade.
<b>Clays:</b>			
Engelhard Corp., Specialty Chemicals Div.	Menlo Park Edison, NJ 08817	Open pit mines and plant.	Brevard.
The Feldspar Corp., EPK Div. <sup>1</sup>	Box 8 Edgar, FL 32049	----do-----	Putnam.
Florida Solite Corp-----	Box 297 Green Cove Springs, FL 32043	----do-----	Clay.
Floridin Co-----	Box 187 Berkeley Springs, WV 25411	----do-----	Gadsden.
Mid-Florida Mining Co-----	Box 68-F Lowell, FL 32663	----do-----	Marion.
<b>Gypsum (calcined):</b>			
Jim Walter Corp-----	Box 135 Jacksonville, FL 32226	Plant-----	Duval.
National Gypsum Co-----	4100 First International Bldg. Dallas, TX 57270	----do-----	Hillsborough.
USG Corp-----	101 South Wacker Dr. Chicago, IL 60606	----do-----	Duval.
<b>Lime:</b>			
Dixie Lime & Stone Co. <sup>2</sup> ----	Drawer 217 Sumterville, FL 33585	----do-----	Sumter.
<b>Peat:</b>			
Atlas Peat & Soil Inc-----	Box 867 Boynton Beach, FL 33435	Bog-----	Palm Beach.
TU-OO Peat-----	9601 Bear Road Sebring, FL 33870	Bog-----	Highlands.
<b>Perlite (expanded):</b>			
Airlite Processing Corp. of Florida.	Route 2, Box 740 Vero Beach, FL 32960	Plant-----	Indian River.
Armstrong Cork Co-----	Box 1991 Pensacola, FL 35289	----do-----	Escambia.
Chemrock Corp-----	End of Osage St. Nashville, TN 37208	----do-----	Duval.
W. R. Grace & Co. <sup>3</sup> -----	62 Whittemore Ave. Cambridge, MA 02140	----do-----	Broward.
<b>Phosphate rock:</b>			
Agrico Chemical Co-----	Box 1110 Mulberry, FL 33860	Open pit mines and plants.	Polk.
AMAX Chemical Inc-----	402 South Kentucky Ave. Lakeland, FL 33801	Open pit mine and plant.	Hillsborough.
Beker Phosphate Corp-----	Box 9034 Bradenton, FL 33506	----do-----	Manatee.
Brewster Phosphates-----	Bradley, FL 33835-----	Open pit mines and plant.	Hillsborough and Polk.
CF Industries Inc-----	Box 790 Plant City, FL 33566	Open pit mine and plant.	Hardee.
Estech Inc-----	Box 208 Bartow, FL 33830	Open pit mines	Polk.
Gardinier Inc-----	Box 3269 Tampa, FL 33601	Open pit mine and plant.	Do.
W. R. Grace & Co-----	Box 471 Bartow, FL 33830	Open pit mines and plant.	Do.
International Minerals & Chemical Corp.	Box 867 Bartow, FL 33830	----do-----	Do.
Mobil Mining and Minerals Co	Box 311 Nichols, FL 33863	----do-----	Do.
Occidental Chemical Co	White Springs, FL 32096	----do-----	Hamilton.
USS Agri-Chemicals Inc-----	Box 867 Fort Meade, FL 33841	Open pit mine and plant.	Polk.
<b>Sand and gravel:</b>			
Florida Rock Industries Inc., Shands & Baker.	Box 4667 Jacksonville, FL 32201	Pits-----	Clay, Glades, Lake, Marion, Polk, Putnam.
General Development Corp--	1111 South Bayshore Dr. Miami, FL 33131	----do-----	Hendry, St. Lu- cie, Sarasota.
E. R. Jahna Industries Inc., Ortona Sand Co. Div.	102 East Tillman Ave. Lake Wales, FL 33853	----do-----	Glades, Lake, Polk.
Silver Sand Co. of Clermont Inc.	Route 1, Box US1 Clermont, FL 32711	Pit-----	Lake.
<b>Staurolite:</b>			
Associated Minerals (USA) Ltd. Inc. <sup>4</sup>	Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. du Pont de Nemours & Co. Inc. <sup>4</sup>	Du Pont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Florida Crushed Stone Co ---	Box 317 Leesburg, FL 32748	Quarries -----	Hernando and Sumter.
Florida Rock Industries Inc --	Box 4667 Jacksonville, FL 32201	-----do-----	Alachua, Collier, Hernando, Lee, Levy, St. Lucie, Taylor.
Rinker Southeastern Materials Inc.	Box 5230 Hialeah, FL 33014	-----do-----	Dade.
Tarmac Florida Inc -----	Box 8648 Deerfield Beach, FL 33441	Quarry -----	Do.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	Quarries -----	Broward and Dade.

<sup>1</sup>Also construction and industrial sand and gravel.

<sup>2</sup>Also crushed stone.

<sup>3</sup>Also exfoliated vermiculite.

<sup>4</sup>Also titanium concentrates.



# The Mineral Industry of Georgia

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

By Doss H. White, Jr.,<sup>1</sup> and Bruce J. O'Connor<sup>2</sup>

In 1986, Georgia's nonfuel mineral production exceeded the \$1 billion value level for the first time. A substantial increase, \$140 million, in the value of clays, construction sand and gravel, and crushed stone accounted for the new record.

Table 1.—Nonfuel mineral production in Georgia<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	8,679	\$600,029	8,671	\$575,097	9,827	\$669,200
Gem stones -----	NA	<sup>e</sup> 20	NA	<sup>e</sup> 20	NA	20
Sand and gravel:						
Construction ----- thousand short tons	5,347	13,623	<sup>e</sup> 5,000	<sup>e</sup> 13,400	8,126	23,222
Industrial ----- do.	478	6,795	571	6,675	W	W
Stone:						
Crushed ----- do.	<sup>e</sup> 45,900	<sup>e</sup> 220,000	52,062	256,588	<sup>e</sup> 56,700	<sup>e</sup> 293,100
Dimension ----- do.	<sup>r</sup> <sup>e</sup> 184	<sup>r</sup> <sup>e</sup> 19,660	<sup>r</sup> 183	19,466	<sup>e</sup> 199	<sup>e</sup> 20,678
Talc ----- do.	15	104	16	111	9	61
Combined value of barite, bauxite (1984), cement, feldspar, iron oxide pigments (crude), kyanite, mica (scrap), peat, and value indicated by symbol W -----	XX	79,914	XX	74,718	XX	85,174
Total -----	XX	<sup>r</sup> 940,145	XX	946,075	XX	1,091,455

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Georgia in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Baldwin	Stone (crushed).
Barrow	Do.
Bartow	Barite, iron oxide pigments, clays.
Bibb	Clays.
Carroll	Stone (crushed).
Cherokee	Do.
Clarke	Do.
Clayton	Do.
Cobb	Do.
Columbia	Stone (crushed), clays.
Columbus (city)	Clays.
Cook	Peat.
Coweta	Stone (crushed).
Decatur	Clays.
De Kalb	Stone (crushed), stone (dimension).
Douglas	Stone (crushed), clays.
Elbert	Stone (dimension), stone (crushed).
Fannin	Stone (dimension).
Fayette	Stone (crushed).
Floyd	Stone (crushed), clays.
Forsyth	Stone (crushed).
Fulton	Cement, stone (crushed), clays.
Gilmer	Stone (crushed).
Gordon	Do.
Greene	Stone (dimension).
Gwinnett	Stone (crushed).
Habersham	Do.
Hall	Do.
Hart	Mica.
Heard	Stone (crushed).
Henry	Do.
Houston	Cement, stone (crushed), clays.
Jasper	Feldspar.
Jefferson	Clays.
Jones	Stone (crushed).
Lee	Do.
Lincoln	Kyanite.
Long	Sand (industrial).
Lumpkin	Stone (crushed).
Macon	Clays.
Madison	Stone (dimension).
Marion	Sand (industrial).
Miller	Stone (crushed).
Monroe	Do.
Murray	Talc.
Newton	Stone (crushed).
Oglethorpe	Stone (dimension).
Paulding	Stone (crushed).
Pickens	Stone (dimension), stone (crushed).
Polk	Stone (crushed).
Rabun	Do.
Richmond	Stone (crushed), clays.
Screven	Peat.
Spalding	Stone (crushed).
Stephens	Do.
Sumter	Clays, bauxite.
Thomas	Clays, sand (industrial).
Troup	Stone (crushed).
Twiggs	Clays.
Walker	Stone (crushed).
Warren	Clays, stone (crushed).
Washington	Clays.
Whitfield	Stone (crushed).
Wilkes	Stone (dimension).
Wilkinson	Clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Georgia business activity

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	5,844	5,975	6,104
Total civilian labor force	do.	2,761	2,880	3,014
Unemployment	percent	6.0	6.5	5.9
<b>Employment (nonagricultural):</b>				
Mining total	thousands	7.8	8.1	8.4
Manufacturing total	do.	546.5	557.1	564.6
Primary metal industries	do.	16.2	16.5	15.4
Stone, clay, and glass products	do.	18.8	19.9	20.8
Chemicals and allied products	do.	18.9	19.3	19.2
Construction	do.	131.5	143.8	156.2
Transportation and public utilities	do.	156.5	163.0	166.5
Wholesale and retail trade	do.	602.4	643.0	669.6
Finance, insurance, real estate	do.	128.3	136.8	145.3
Services	do.	493.7	469.3	505.7
Government and government enterprises	do.	442.0	448.7	458.6
Total	do.	2,448.7	2,569.8	2,675.0
<b>Personal income:</b>				
Total	millions	\$68,992	\$75,508	\$82,078
Per capita		\$11,805	\$12,638	\$13,446
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		41.0	40.6	40.9
Total average hourly earnings, production workers		\$7.6	\$8.1	\$8.3
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$1,198	\$993	\$1,170
Nonfarm	do.	\$52,108	\$57,643	\$63,053
Mining total	do.	\$287	\$312	\$329
Manufacturing total	do.	\$11,261	\$12,078	\$13,016
Primary metal industries	do.	\$449	\$478	\$498
Stone, clay, and glass products	do.	\$425	\$466	\$516
Chemicals and allied products	do.	\$510	\$552	\$584
Construction	do.	\$3,486	\$3,915	\$4,484
Transportation and public utilities	do.	\$5,021	\$5,409	\$5,763
Wholesale and retail trade	do.	\$10,281	\$11,568	\$12,343
Finance, insurance, real estate	do.	\$3,063	\$3,531	\$4,169
Services	do.	\$9,321	\$10,701	\$12,145
Government and government enterprises	do.	\$9,185	\$9,892	\$105,33
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup>		70,289	73,141	76,896
Value of nonresidential construction <sup>4</sup>	millions	\$1,993.0	\$2,484.9	\$2,477.9
Value of State road contract awards <sup>4</sup>	do.	\$452.0	\$560.0	\$569.0
Shipments of portland and masonry cement to and within the State	thousand short tons	2,984	3,103	3,466
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$940.1	\$946.1	\$1,091.5
Value per capita		\$161	\$158	\$179

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Data do not add to total shown because of independent rounding.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

**Trends and Developments.**—In 1986, Georgia's economy grew faster than the Nation's. Although construction activity expanded slower than the year before, the sale of construction mineral commodities—common clay and shale for cement, brick, and pipe manufacture and crushed stone and sand and gravel for asphalt and concrete aggregates—accounted for almost 30% of the State's mineral sales.

Kaolin was Georgia's principal mineral commodity in terms of value, accounting for over 50% of mineral sales during the past

several years. Paper coating was the principal market for most kaolin producers, accounting for 70% to 80% of their sales.

In 1985, the industry was in a slump with many plants operating at approximately 75% capacity because of a decrease in coated paper output. However, in 1986, the demand for kaolin-coated paper reached an all-time high, and this, coupled with an increase in the exports of kaolin, fueled by the devaluation of the dollar, pushed kaolin sales and production to a record 6.8 million short tons valued at \$635 million.

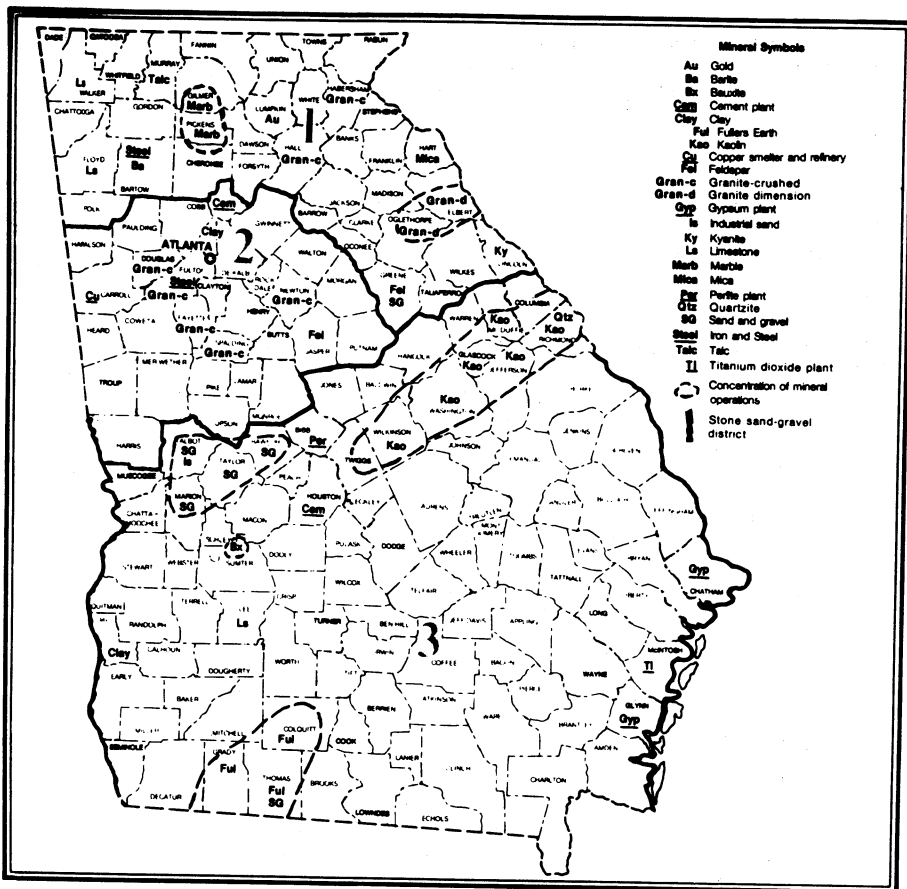


Figure 1.—Principal mineral-producing localities in Georgia.

The Georgia Port Authority's dry bulk terminal on Colonel's Island became operational. The first shipment through the new facility was 7,000 short tons of crushed granite for road aggregate for the Bahamas.

Associated Minerals Inc., a Florida subsidiary of an Australian mining company, was asked to delay offshore work to avoid conflict with endangered right whales. Associated Minerals planned to sample for heavy minerals in a 954-square-mile area starting at the State's 3-mile limit and extending 10 miles offshore from south of Jekyll Island to north of Tybee Island.<sup>3</sup>

**Legislation and Government Programs.**—During 1986, the Georgia Geologic Survey (GGS) published 19 reports and responded to almost 3,000 information requests on the State's geology, hydrology, and mineral resources. In a cooperative

program with the U.S. Geological Survey (USGS), the GGS (1) maintained a statewide network of observation wells equipped with continuous water-level recorders, (2) published studies by the USGS on the hydrogeology of the State, and (3) maintained a program with the Topographic Division of the USGS for the production of topographic maps. Currently, Georgia has 100% coverage at the 1:24,000, 1:100,000, and 1:250,000 scales.

The GGS' Hydrology Program conducted investigations of the State's water resources, and the Geology Program conducted investigations of the economic mineral resources and framework geology of the State. Additionally, the GGS provided technical assistance and information to mining companies and compiled a mining directory and a geoscience facilities direc-

tory. Other activities included a major revision of the Cenozoic stratigraphy of the Coastal Plain and an investigation of the geology of the fall-line area of east-central Georgia. With a grant from the U.S. Min-

erals Management Service, the GGS was studying the phosphate and heavy mineral resources of coastal Georgia, including the Continental Shelf.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Although construction activity slackened to some degree from that experienced in 1985, Georgia's economy grew faster than the Nation's, and the growth was reflected in the demand for industrial minerals. The value of industrial minerals production exceeded that of 1985 by approximately \$145 million, and Georgia ranked fourth nationally in industrial minerals output.

**Barite.**—New Riverside Ochre Co. and Cyprus Industrial Minerals Co., formerly Paga Mining Co., continued as the two remaining barite producers in the historic Cartersville mining district. In the early 1900's, several score barite mining firms were in operation.

Both New Riverside Ochre and Cyprus Industrial Minerals used draglines to mine the ore horizons; crude ore was trucked to nearby beneficiation plants where flotation cells produced a barite concentrate. New Riverside Ochre concentrate was trucked to Chemical Products Corp. in Cartersville for the manufacture of barium chemicals, while Cyprus Industrial Minerals concentrate was trucked to a nearby grinding and

bagging plant. The Cyprus Industrial Minerals plant produced several filler grades of barite for the paint, paper, plastics, and rubber markets.

New Riverside Ochre also produced an iron oxide pigment, and Cyprus Industrial Minerals ground marble shipped from Alabama to produce a product used as a filler and extender. New Riverside Ochre planned to complete mining and reclamation on its Cartersville mine in 1987-88 and move to a new area in Emerson, south of the current operation.

Chemical Products petitioned the U.S. Department of Commerce (DOC) and the U.S. International Trade Commission concerning barium chloride dumping by China from October 1, 1984, to September 30, 1985. The review of the antidumping duty order indicated the existence of dumping margins during the period, and DOC made a preliminary determination to assess duties.

**Cement.**—The State's two cement producers manufactured both portland and masonry cements; output increased approximately 3% over that reported for 1985. Information on the two cement producers is given in the following table:

Company	Location	Number of kilns	Process type	Capacity (short tons)
Blue Circle Inc	Atlanta	4	2 wet, 2 dry	733,000
Medusa Cement Co	Clinchfield	2	Dry	300,000

Lehigh Portland Cement Co. operated a distribution terminal near Atlanta. Cement was obtained from a Lehigh plant in Leeds, AL.

**Clays.**—The State continued as the leading clay producer in the United States. Historically, clay production has accounted for almost 60% of Georgia's mineral value, and this was again true in 1986. Kaolin was the leading clay commodity produced in terms of value (95%), followed by fuller's

earth (4%), and common clay (1%). The State's clay industry was comprised of 29 companies operating 105 mines in a 20-county area.

**Kaolin.**—The increase in kaolin output and value is noted in table 4. Major kaolin producers, locations, and markets are noted in table 5. During the year, Anglo-American Clays Corp. of Sandersville, a subsidiary of ECC American Inc., completed the largest expansion in the company's history.



**Table 4.—Georgia: Clays sold or used by producers**  
(Thousand short tons and thousand dollars)

Year	Kaolin		Fuller's earth		Common clay	
	Quantity	Value	Quantity	Value	Quantity	Value
1982	5,268	445,389	534	27,558	970	2,821
1983	5,886	523,407	692	32,826	1,281	3,773
1984	6,508	562,697	569	32,415	1,601	4,913
1985	6,345	534,980	593	34,628	1,733	5,489
1986	6,778	635,220	532	26,322	2,516	7,658

**Table 5.—Georgia: Principal kaolin producers in 1986<sup>1</sup>**

Company	Location	Capacity <sup>2</sup> (thousand short tons)	Primary use
Albion Kaolin Co	Augusta	180	Fiberglass, ceramics, rubber, refractories.
Cyprus Industrial Minerals Co	Sandersville	200	Paper and refractories.
ECC American Inc.	do	+700	All grades of coating, delaminated, calcined clays.
Engelhard Corp., Specialty Chemicals Div	do	+1,000	Paper, paint, polymers.
	Irwin		
	McIntyre		
Evans Clay Co	Gardner	160	Rubber, paper filler, ceramics, adhesives, insecticides.
	Irwin		
Georgia Kaolin Co	Dry Branch	1,600	Paper, paint, polymers.
	Sandersville		
J. M. Huber Corp	Wrens	900	Paper, rubber, plastics, paint, adhesives.
	do		
Nord Kaolin Co	Huber	270	Paper coating, filler, delaminated grades.
	Jeffersonville		
Thiele Kaolin Co	Sandersville	600	Paper coating, extender, filler grades.
	Wrens		
Wilkinson Kaolin Associates Ltd	Gordon	100	Ceramics, paper filler, extender grades.

<sup>1</sup>Excludes Andersonville District and kaolin used in cement manufacture.

<sup>2</sup>Industrial Minerals (London). Dec. 1979, pp. 31-33; July 1987, p. 67.

**Table 6.—Georgia: Kaolin sold or used by producers, by county**

County	1985			1986		
	Number of mines	Quantity (thousand short tons)	Value (thousands)	Number of mines	Quantity (thousand short tons)	Value (thousands)
Jefferson	1	W	W	1	W	W
Richmond <sup>1</sup>	2	352	\$13,144	2	319	\$11,547
Twiggs	6	1,266	112,270	6	1,267	121,617
Washington	5	2,330	211,131	5	1,675	143,522
Wilkinson	4	778	88,157	4	1,499	195,249
Other <sup>2</sup>	7	1,619	110,278	7	2,018	163,285
Total	25	6,345	534,980	25	6,778	635,220

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

<sup>1</sup>Includes Jefferson County.

<sup>2</sup>Includes Columbia, Houston, Macon, Sumter, and Warren Counties and data indicated by symbol W.

Table 7.—Georgia: Kaolin sold or used by producers, by kind

Kind	1985		1986	
	Short tons	Value	Short tons	Value
Air-float .....	739,563	\$31,824,375	913,849	\$35,111,526
Calcined <sup>1</sup> .....	945,106	100,875,939	915,581	159,331,295
Delaminated .....	735,503	72,075,882	915,641	56,809,167
Unprocessed .....	196,312	5,594,126	210,336	7,297,076
Water-washed .....	3,728,721	324,609,679	3,823,085	376,670,749
<b>Total</b> .....	<b>6,345,205</b>	<b>534,980,001</b>	<b>6,778,492</b>	<b>635,219,813</b>

<sup>1</sup>Includes both low-temperature filler and high-temperature refractory grades.

Table 8.—Georgia: Kaolin sold or used by producers, by use

(Short tons)

Use	1985	1986
<b>Domestic:</b>		
Adhesives .....	80,812	50,416
Chemicals .....	110,517	110,000
Fiberglass and mineral wool .....	170,503	230,039
Firebrick, blocks and shapes .....	3,841	65,333
Floor and wall tile, ceramic .....	8,412	16,868
Paint .....	172,559	219,990
Paper coating .....	2,263,846	2,313,664
Paper filling .....	1,171,335	1,332,351
Plastics .....	41,062	40,997
Rubber .....	122,884	51,667
Sanitary ware .....	135,711	147,065
Whiteware .....	16,971	21,887
Other .....	761,816	774,104
<b>Exports</b> .....	<b>1,284,936</b>	<b>1,404,061</b>
<b>Total</b> .....	<b>6,345,205</b>	<b>6,778,492</b>

*Fuller's Earth.*—Georgia's fuller's earth industry was composed of five companies in southwestern Georgia and a sixth in the central part of the State. Mining was by surface methods; processing consisted of

drying, crushing, milling, screening, and bagging. Principal markets were the pet and industrial absorbent sectors. Production totaled about 532,000 short tons valued at about \$26 million.

Table 9.—Georgia: Fuller's earth sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind	1984		1985		1986	
	Quantity	Value	Quantity	Value	Quantity	Value
Attapulgit .....	364	23,602	387	25,333	318	15,657
Montmorillonite .....	205	8,813	206	9,295	214	10,665
<b>Total</b> .....	<b>569</b>	<b>32,415</b>	<b>593</b>	<b>34,628</b>	<b>532</b>	<b>26,322</b>

*Common Clay.*—The strong demand for building materials, notably brick and clay pipe, buoyed the State's eight common clay producers, who exceeded 1985 production by almost 800,000 short tons. The common clay and/or shale sector of the industry had operations in four counties in the northwestern part of the State and two counties in central and east-central Georgia. In 1986, over 80% of the clay mined instate was used in brick manufacture.

*Feldspar.*—The Feldspar Corp. produced

both high potash and soda feldspar ore from surface mines in Greene and Jasper Counties. Feldspar's beneficiation plant was in Monticello, where a concentrate was produced by flotation. Output fell below the 1985 level. Instate usage of total U.S. feldspar output remained high, with Georgia's glass and pottery manufacturers consuming 91,600 short tons in 1986, 3,700 tons below the 1985 level.

*Gypsum.*—Three companies imported gypsum from Nova Scotia and Newfound-

land, Canada, for the production of gypsum board.

**Kyanite and Mullite.**—Pasco Mining Corp., one of two kyanite producers in the United States, terminated operations at its Lincoln County mine and plant in October. Economics and foreign competition were factors in the closing.

Synthetic mullite was produced by the Mulcoa Div. of C-E Minerals Inc. at a plant in Sumter County in the southern part of the Andersonville bauxite district. Mullite was produced by sintering a bauxite and kaolin mixture.

**Lime.**—Brunswick Pulp and Paper Co. regenerated lime as part of its papermaking operation.

**Mica.**—Franklin Mineral Products Co. Inc. operated a surface mine and beneficiation plant in Hart County in northeastern Georgia. The company, a subsidiary of the Mearl Corp., produced a wet-ground product and also shipped crude ore to a wet-grinding plant in Franklin, NC. Much of the company's output was used by the parent

company to manufacture pearlescent pigments.

**Perlite (Expanded).**—Armstrong World Industries Inc., Macon, imported Greek perlite for expanding and use by the insulation industry.

**Pyrite.**—A pyrite concentrate was recovered during kyanite beneficiation at Pasco. Pasco suspended operations in October.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was produced by 37 companies operating 47 pits in 32 counties. Output of 8 million short tons exceeded the 1985 estimate by 3 million tons. The Taylor-Talbot Counties contiguous area in the west-central part of the State accounted for almost 50% of Georgia's production.

**Table 10.—Georgia: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,469	\$4,714	\$3.21
Plaster and gunite sands -----	W	W	2.62
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	177	529	2.99
Asphaltic concrete aggregates and other bituminous mixtures -----	32	148	4.63
Road base and coverings -----	W	W	2.68
Fill -----	178	215	1.21
Other -----	597	1,680	2.81
Other unspecified <sup>1</sup> -----	5,672	15,936	2.81
Total or average -----	28,126	23,222	2.86

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Table 11.—Georgia: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	W	W	W	W	1,237	3,671
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	--	--	28	W	146	391
Other -----	--	--	20	120	435	1,178
Other unspecified <sup>3</sup> -----	747	2,320	560	1,795	4,952	13,747
Total -----	747	2,320	608	1,915	6,770	18,987

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road base and coverings.

<sup>3</sup>Includes fill, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 11 presents end-use data for construction sand and gravel production in the three Georgia districts that are depicted in figure 1.

**Industrial.**—One company produced industrial sand for blasting, containers, fiberglass, filtration, molding, traction, and other applications.

**Slag—Iron and Steel.**—Atlantic Steel Co. operated minimills in Atlanta and Cartersville. Slag, a byproduct of the steelmaking process, was marketed for aggregate applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Georgia's crushed stone industry was primarily in the northern part of the State. The limestone and slate sectors were in the northwest, granite was in the north-central and northeast, and marble was in the north-central. Quartzite was mined in the east-central sector. Tertiary limestones and marls were mined in southern Georgia.

Georgia continued to rank among the leading States in ground marble output for the extender and filler markets. Georgia Marble Co. operated four underground room-and-pillar mines in Pickens and Gilmer Counties to produce a feed for several wet- and dry-grinding plants. Output was sold to several dozen industries for a myriad of uses.

**Dimension Granite.**—Georgia's granite producers accounted for 26% of the output in the United States. Georgia remained as the top-ranked dimension granite State, and Elberton was the leading dimension granite district. The district, Elbert, Madison, and Oglethorpe Counties, contained over 35 quarries within a 25-mile radius of Elberton. A significant amount of the district's output was trucked to Savannah and shipped to Japan and other overseas markets.

**Dimension Marble.**—Georgia Marble continued to operate several quarries in the Long Swamp Valley area of Pickens County near the community of Tate. The company's Memorial Div. operated a finishing plant at the quarry complex for the production of markers, mausoleums, and monuments. The Structural Div. at Nelson used marble

from the Tate quarries to fabricate panels for interiors and facades.

**Other Dimension Stone.**—Several firms in the northern part of the State quarried a variety of metamorphic rock for flagstone and related applications. Metagraywacke, the principal stone mined, was used in both interior and exterior applications.

**Strontium Compounds.**—Cartersville in northwestern Georgia was the headquarters of the only major strontium producer in the United States. Chemical Products imported celestite from Mexico to produce strontium carbonate, used primarily in the manufacture of television picture faceplates.

Chemical Products also produced barium chemicals from barite mined by New River-side Ochre.

**Talc.**—United Catalysts Inc., a U.S.-based subsidiary of Süd-Chemie AG of the Federal Republic of Germany, purchased Southern Talc Co. of Chatsworth in north-central Georgia. The new owners closed the Cliff Mine and reopened the Earnest Mine. A contract miner was hired to produce the higher grade talc in the Earnest Mine. Raw talc was trucked to the 40,000-short-ton-per-year mill in Chatsworth where it was ground for sale to the red firing tile, asphalt dusting, insecticide carrier, and plastic and rubber mold-release-compound markets.<sup>4</sup>

## METALS

**Arsenic.**—Koppers Co. Inc. in Conley processed low-grade arsenic trioxide obtained from roasting Canadian gold ore. Arsenic acid was manufactured for use in the production of chromated copper arsenate-based wood preservative.

**Copper.**—Southwire Co. operated a smelter, refinery, and rod mill at Carrollton in west-central Georgia. Copper scrap and purchased blister were used as plant feed.

**Gold.**—Several companies in Lumpkin and White Counties recovered gold as a coproduct of sand and gravel production. United States Borax & Chemical Corp. was involved in the exploration of the Royal Vindicator property in northeastern Georgia. Preliminary studies have shown drill-indicated reserves of 351,300 short tons of ore grading 0.15 troy ounce of gold per ton. Additional reserves included 40,000 tons of ore grading 0.26 ounce of gold per ton of ore in the original mine and 125,000 tons of ore grading 0.075 ounce of gold per ton in the tailings.<sup>5</sup>

**Iron Oxide Pigments.**—Cartersville-based New Riverside Ochre continued as the only crude pigment producer in the South-

east. New Riverside Ochre mined and processed crude pigments for a coloring agent in cement and mortars.

**Iron and Steel.**—Atlantic Steel operated two minimills in Georgia. Data on the two mills are given below.

Location	Number of furnaces	Capacity (short tons)
Atlanta -----	2	90
Cartersville -----	1	100

**Titanium Dioxide.**—Kemira Oy, Helsinki, Finland, operated a 110,000-short-ton-per-year titanium dioxide plant at Sa-

vannah. The 600-employee plant, which uses both the chloride and sulfate processes, produced pigments for the paint, paper, and plastics industries. Raw materials used included titanium-rich slag from Canada, rutile from Florida and Australia, and aragonite from the Bahamas.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Principal geologist, Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.

<sup>3</sup>Atlanta Journal/Constitution. Mining Firm To Delay Work Because of Whales Breeding Off Georgia Coast. Feb. 16, 1986.

<sup>4</sup>Industrial Minerals (London). Georgia Talc Reopened. Nov. 1986, p. 19.

<sup>5</sup>Mining Record. Joint Venture Acquires Gold Properties From U.S. Borax. Apr. 15, 1987.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Barite:</b>			
Cyprus Industrial Minerals Co. -----	Box 130 Cartersville, GA 30120	Open pit mine and mill.	Bartow.
New Riverside Ochre Co. <sup>1</sup> -----	Box 387 Cartersville, GA 30120	-----do-----	Do.
<b>Bauxite:</b>			
Mullite Co. of America -----	Box 37 Andersonville, GA 31711	-----do-----	Macon and Sumter.
<b>Cement:</b>			
Blue Circle Inc -----	2520 Paul Ave., NW. Atlanta, GA 30318	Plant -----	Fulton.
Medusa Cement Co. -----	Box 5668 Cleveland, OH 44101	-----do-----	Houston.
<b>Clays:</b>			
American Industrial Clay Co. -----	433 North Broad St. Elizabeth, NJ 07207	Open pit mines	Warren and Washington.
Engelhard Corp., Specialty Chemicals Div. -----	Menlo Park Edison, NJ 08817	-----do-----	Decatur, Washington, Wilkinson.
J. M. Huber Corp -----	Thornall St. Edison, NJ 08817	-----do-----	Twiggs and Warren.
Thiele Kaolin Co -----	Box 1056 Sandersville, GA 31082	-----do-----	Warren and Washington.
<b>Feldspar:</b>			
The Feldspar Corp -----	Box 99 Spruce Pine, NC 28777	Open pit mines and plant.	Greene and Jasper.
<b>Gypsum (calcined):</b>			
Genstar Gypsum Products Co -----	Box 2580 Irving, TX 75061	Plant -----	Chatham.
Georgia-Pacific Corp -----	133 Peachtree St., NE. Atlanta, GA 30303	-----do-----	Glynn.
National Gypsum Co. -----	4500 Lincoln Plaza Dallas, TX 75201	-----do-----	Chatham.
<b>Kyanite:</b>			
Pasco Mining Corp -----	Box 649 Washington, GA 30673	Open pit mine and plant.	Lincoln.
<b>Mica:</b>			
Franklin Mineral Products Co. Inc --	Box 0 Wilmington, MA 01887	-----do-----	Hart.
<b>Perlite (expanded):</b>			
Armstrong World Industries Inc. -----	1010 Concord Lancaster, PA 17604	Plant -----	Bibb.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Atlanta Sand & Supply Co -----	Route 1 Roberta, GA 31078	Open pit mine	Crawford.
Brown Bros. Sand Co -----	Box 82 Howard, GA 31039	Open pit mines	Talbot.
Howard Sand Co -----	Box 118 Butler, GA 31006	-----do-----	Talbot and Taylor.
<b>Industrial:</b>			
Montgomery Sand Co., a subsidi- ary of Florida Crushed Stone Co. -----	Box 2117 Thomasville, GA 31792	Open pit mine	Thomas.
The Morie Co. Inc -----	1201 North High St. Millville, NJ 08332	-----do-----	Marion.

See footnote at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone (1985): Crushed:			
Florida Rock Industries Inc -----	Box 4667 Jacksonville, FL 32201	Quarries ----	Clayton, Fayette, Floyd, Monroe, Spalding.
Georgia Marble Co -----	Box 409 Lithonia, GA 30058	----do----	De Kalb, Douglas, Forsyth, Gilmer, Hall, Newton, Pickens.
Martin Marietta Aggregates ----	Box 30013 Raleigh, NC 27612	----do----	Jones, Lee, Richmond, Warren.
North Georgia Crushed Stone Co., a division of Koppers Co. Inc.	Box 458 Lithonia, GA 30058	----do----	Clarke, De Kalb, Fayette, Fulton, Habersham, Hall, Stephens, Walker.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	----do----	Carroll, Cobb, Coweta, Douglas, Fulton, Gwinnett, Henry, Troup.
Dimension:			
Bennie & Harvey Inc -----	Box 958 Elberton, GA 30635	Quarry and finishing plant.	Oglethorpe.
Coggings Granite Industries Inc -	Box 250 Elberton, GA 30635	----do----	Madison.
Granite Panelwall Co., a division of Florida Crushed Stone Co.	Box 898 Elberton, GA 30635	----do----	Elbert.

<sup>1</sup>Also produced crude iron oxide pigments.



# The Mineral Industry of Hawaii

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

By Fred V. Carrillo<sup>1</sup>

Hawaii's nonfuel mineral production value in 1986 was \$70.4 million, an increase of 32% over that of 1985. The rise was attributed to the continuing growth in the construction industry and increased production of crushed stone. According to the Bank of Hawaii, the construction industry, which is responsible for most of the nonfuel mineral industry demand, was up 27% in total value

of construction completed during the year compared with that of 1985.

Industrial minerals accounted for the total mineral value. Production of cement, lime, pumice, construction sand and gravel, and crushed stone accounted for over 98% of the total value. Hawaii ranked 44th in the Nation in value of minerals produced in 1986, the same ranking as in 1985.

Table 1.—Nonfuel mineral production in Hawaii<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons..	5	\$792	7	\$588	7	\$1,078
Portland ----- do. ....	186	18,282	215	16,050	287	24,253
Gem stones -----	NA	<sup>e</sup> 25	NA	<sup>e</sup> 25	NA	25
Lime ----- thousand short tons..	W	W	W	W	3	W
Sand and gravel (construction) ----- do. ....	436	2,031	<sup>e</sup> 500	<sup>e</sup> 2,100	605	2,666
Stone (crushed) ----- do. ....	<sup>e</sup> 5,400	<sup>e</sup> 29,700	5,627	34,183	<sup>e</sup> 7,100	<sup>e</sup> 42,100
Combined value of other industrial minerals and values indicated by symbol W -----	XX	<sup>f</sup> 417	XX	<sup>f</sup> 326	XX	290
Total -----	XX	51,247	XX	53,272	XX	70,412

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



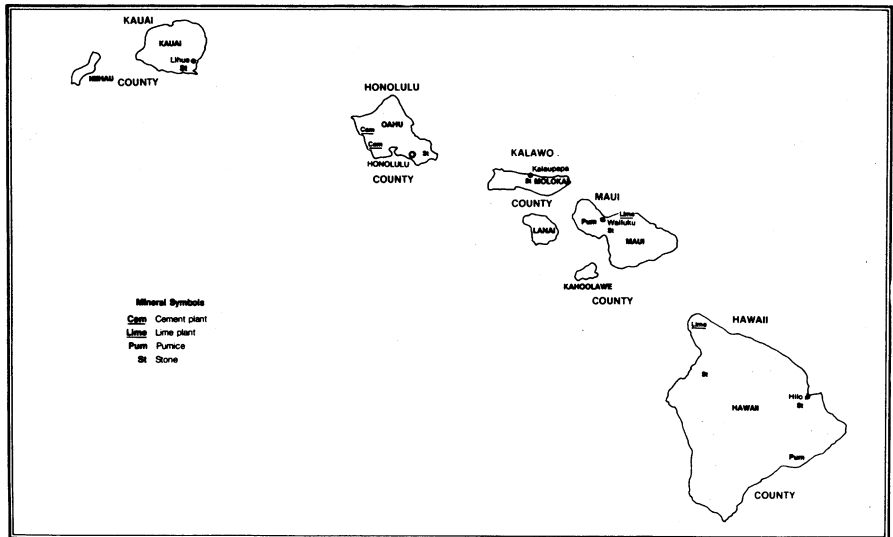


Figure 1.—Principal mineral-producing localities in Hawaii.

Table 2.—Nonfuel minerals produced in Hawaii in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Hawaii	Stone (crushed), pumice.
Honolulu	Stone (crushed), cement.
Kauai	Stone (crushed).
Maui	Stone (crushed), lime, pumice.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—Research was continued by Federal and State agencies on cobalt-rich manganese crusts found distributed on seamounts underlying the

200-mile U.S. Exclusive Economic Zone (EEZ) surrounding the Hawaiian Archipelago. The mineralized crusts occur on the slopes of submarine ridges and seamounts at water depths between 2,400 and 7,200 feet. In addition to cobalt and manganese, the crusts also contain significant amounts of nickel and platinum.

Honolulu was one of seven major metropolitan areas within the U.S. EEZ to have a comprehensive study of sand and gravel deposits completed by the Bureau of Mines for the purpose of selecting offshore deposits for consideration as near-term lease offerings. Based upon preliminary market and resource analysis, the Hawaiian site was found to be uneconomical for offshore mining at present.

Table 3.—Indicators of Hawaii business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population	1,036	1,051	1,062
Total civilian labor force	472	478	488
Unemployment	5.6	5.6	4.8
<b>Employment (nonagricultural):</b>			
Mining total <sup>1</sup>	0.1	0.1	0.1
Nonmetallic minerals except fuels <sup>1</sup>	.1	.1	.1
Manufacturing total	21.9	21.9	22.1
Primary metal industries <sup>1</sup>	(?)	(?)	(?)
Stone, clay, and glass products <sup>1</sup>	1.1	1.1	1.1
Petroleum and coal products <sup>1</sup>	.5	.5	.5
Construction	15.8	17.0	19.0
Transportation and public utilities	32.0	33.2	34.0
Wholesale and retail trade	111.4	115.6	116.7

See footnotes at end of table.

Table 3.—Indicators of Hawaii business activity —Continued

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average—Continued</b>				
Employment (nonagricultural)—Continued				
Finance, insurance, real estate	thousands	31.9	31.9	32.9
Services	do	107.9	112.6	118.7
Government and government enterprises	do	91.8	93.3	98.8
Total <sup>3</sup>	do	412.7	425.7	437.2
<b>Personal income:</b>				
Total	millions	\$13,636	\$14,804	\$15,814
Per capita		\$13,161	\$14,080	\$14,886
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		38.1	37.4	38.9
Total average hourly earnings, production workers		\$8.4	\$8.7	\$8.9
<b>Earnings by industry:<sup>4</sup></b>				
Farm income	millions	\$267	\$285	\$318
Nonfarm	do	\$10,005	\$10,722	\$11,472
Mining total	do	\$16	\$24	\$24
Nonmetallic minerals except fuels	do	\$1	\$1	\$1
Oil and gas extraction	do	\$15	\$23	\$23
Manufacturing total	do	\$487	\$522	\$551
Primary metal industries	do	\$2	\$1	\$1
Stone, clay, and glass products	do	\$31	\$37	\$40
Petroleum and coal products	do	\$24	\$24	\$23
Construction	do	\$601	\$660	\$760
Transportation and public utilities	do	\$862	\$903	\$974
Wholesale and retail trade	do	\$1,587	\$1,700	\$1,794
Finance, insurance, real estate	do	\$690	\$741	\$833
Services	do	\$2,489	\$2,701	\$2,957
Government and government enterprises	do	\$3,225	\$3,423	\$3,523
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>5</sup>		5,449	7,262	7,217
Value of nonresidential construction <sup>6</sup>	millions	\$139.4	\$309.3	\$325.9
Value of State road contract awards <sup>6</sup>	do	\$45.9	\$45.1	\$69.4
Shipments of portland and masonry cement to and within the State	thousand short tons	191	221	294
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$51.2	\$53.3	\$70.4
Value per capita		\$49	\$51	\$66

<sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Less than 50 employees.<sup>3</sup>Data may not add to totals shown because of independent rounding.<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Hawaiian portland cement production and value increased to 287,000 short tons and \$24.3 million, and masonry cement production increased to 7,331 short tons valued at \$1.1 million in 1986. Of the total portland cement sold, 70% was used in ready-mixed concrete, 15% by concrete product manufacturers, 6% by building material dealers, 6% by highway and other contractors, and 3% by government agencies and other users.

Lone Star Hawaiian Cement Corp. continued to operate at its Barbers Point Plant in the Campbell Industrial Park in Honolulu County on Oahu. Raw materials consumed in portland and masonry cement manufacture included coral, gypsum, limestone, pyrite, sand, sandstone, and volcanic cin-

ders. The coral, limestone, and volcanic cinders were mined at nearby quarries on Oahu; the other raw materials were imported from Australia or Mexico. Kilns at both plants were fired with coal and fuel oil, and electricity was purchased for both. Coal was imported from Australia.

**Lime.**—Hydrated lime was produced by the Hawaiian Commercial & Sugar Co. Ltd. from its calcining operations near Paia, in Maui County. Reported 1986 lime production in Hawaii remained constant in quantity but was slightly lower in value from that reported in 1985.

**Pumice and Pumicite.**—In 1986, both the production and value decreased compared with those of 1985. Pumice was processed in Hawaii County by Volcanite Ltd. at Kailua Kona and mined in Maui County by Maui Pineapple Co. Ltd. of Lahaina. Unpro-

used volcanic ash was mined by the Puna Sugar Co. Ltd. at Keaau, Hawaii County. Principal uses were for road construction, concrete aggregates, and in landscaping.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The trend of recent years was reversed when the construction job count in April 1986 of 16,000 workers increased 4 months in a row and stood at 18,300 jobs by August. Construction sand and gravel production in Hawaii increased 21% from the 1985 estimates to 605,000 short tons; value increased 27% to \$2.7 million. Five active operations reported production in Hawaii during 1986. Principal uses were in concrete aggregates, road base and coverings, asphaltic concrete aggregates, and fill.

**Table 4.—Hawaii: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	76	\$456	\$6.00
Asphaltic concrete aggregates and other bituminous mixtures -----	13	113	8.69
Road base and coverings -----	105	754	7.18
Fill -----	114	399	3.50
Other unspecified <sup>1</sup> -----	297	944	3.18
<b>Total or average -----</b>	<b>605</b>	<b>2,666</b>	<b>4.41</b>

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Estimated crushed stone production of 7.1 million short tons is 26% higher than the reported 1985 production of 5.6 million short tons.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Reno, NV.

**Table 5.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Lone Star Hawaiian Cement Corp	Barbers Point Plant 220 SiKing St., Suite 1700 Honolulu, HI 96813	Cement plant -----	Honolulu.
<b>Lime:</b>			
Hawaiian Commercial & Sugar Co. Ltd.	Box 266 Puunene, HI 96784	Rotary kiln and con- tinuous hydrator.	Maui.
<b>Pumice:</b>			
Maui Pineapple Co. Ltd. -----	Box 445-C Lahaina, HI 96761	Surface mine -----	Do.
Puna Sugar Co. Ltd. -----	Box 120 Keaau, HI 96749	-----do-----	Hawaii.
Volcanite Ltd. -----	Box 3000 Kailua Kona, HI 96740	-----do-----	Do.
<b>Sand and gravel (construction):</b>			
Amelco Corp., Maui Concrete ---	Box 488 Kahului, HI 96732	Plant and pit -----	Maui.
Kauai Sand & Gravel Inc. -----	4247 Kapaia Rd. Lihue, HI 96766	-----do-----	Kauai.
<b>Stone (crushed):</b>			
Ameron Honolulu Construction & Drayage Ltd.	Box 29968 Honolulu, HI 96820	Quarries -----	Honolulu and Maui.
Grace Pacific Corp., Concrete and Rock Div.	91-920 Farrington Hwy. Ewa Beach, HI 96707	-----do-----	Do.
Grove Farm Rock Co. Inc. -----	Puhi Rural Station Lihue, HI 96776	-----do-----	Kauai.
Herbert Tanaka Co -----	87-1748 Farrington Hwy. Waianae, HI 96792	Quarry -----	Honolulu.
Kuwaye Bros. Inc -----	160 Keas St. Hilo, HI 96720	-----do-----	Hawaii.
Lone Star Hawaii Rock Products -	11555 Dublin Canyon Rd. Pleasanton, CA 94566	-----do-----	Honolulu.

# The Mineral Industry of Idaho

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

By W. L. Rice<sup>1</sup> and E. H. Bennett<sup>2</sup>

Idaho's nonfuel mineral production value decreased sharply in 1986, to \$246.7 million, down 31% from that of 1985. Significant increases in the value of gold, construction sand and gravel, and crushed stone were insufficient to balance out drastic decreases in the value of molybdenum, phosphate rock, and silver for 1986.

Table 1.—Nonfuel mineral production in Idaho<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony -----short tons--	557	W	W	W	W	W
Clays <sup>2</sup> ----- thousand short tons--	1	W	2	W	2	W
Copper (recoverable content of ores, etc.) metric tons--	3,701	\$5,455	3,551	\$5,242	W	W
Gem stones-----	NA	€150	NA	€175	NA	\$305
Gold (recoverable content of ores, etc.) troy ounces--	W	W	44,306	14,074	70,440	25,938
Lead (recoverable content of ores, etc.) metric tons--	W	W	33,707	14,169	9,951	4,836
Lime ----- thousand short tons--	87	5,616	93	5,803	89	4,729
Phosphate rock --- thousand metric tons--	4,722	126,586	3,784	€104,000	2,625	55,000
Sand and gravel (construction) thousand short tons--	4,725	13,509	€4,000	€11,400	5,708	14,830
Silver (recoverable content of ores, etc.) thousand troy ounces--	18,869	153,608	18,828	115,645	11,207	61,301
Stone (crushed) --- thousand short tons--	€1,800	€7,100	2,019	6,977	€3,700	€12,700
Zinc (recoverable content of ores, etc.) metric tons--	W	W	W	W	351	294
Combined value of cement, clays (bentonite, common clay (1986), fire clay, kaolin), garnet (abrasive), gypsum (1984), molybdenum, perlite, pumice, sand and gravel (industrial), stone (dimension), vanadium, and values indicated by symbol W	XX	€100,327	XX	€81,181	XX	66,783
Total-----	XX	€412,351	XX	€358,666	XX	246,716

<sup>€</sup>Estimated. <sup>€</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes certain clays; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Idaho in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adams	Stone (crushed).
Bannock	Cement, stone (crushed).
Benewah	Garnet (abrasive), stone (crushed).
Bingham	Phosphate rock.
Blaine	Stone (crushed).
Boise	Gold, silver, stone (crushed).
Bonner	Stone (crushed).
Bonneville	Stone (dimension), pumice, stone (crushed).
Boundary	Stone (crushed).
Butte	Do.
Camas	Gold, silver, lead, copper.
Canyon	Lime.
Caribou	Phosphate rock, vanadium, stone (crushed).
Cassia	Stone (dimension), stone (crushed).
Clark	Stone (crushed), clays.
Custer	Molybdenum, silver, lead, copper, gold, stone (crushed).
Elmore	Stone (crushed).
Franklin	Do.
Fremont	Do.
Gem	Sand (industrial).
Idaho	Stone (crushed), gold, silver, copper, lead.
Kootenai	Stone (crushed).
Latah	Clays.
Lemhi	Stone (crushed).
Oneida	Perlite, pumice.
Owyhee	Silver, gold.
Shoshone	Silver, lead, copper, gold, antimony, zinc.
Twin Falls	Stone (crushed).
Valley	Gold, silver, stone (crushed).
Washington	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Silver remained the leading mineral commodity in terms of value, followed by phosphate rock, molybdenum, gold, sand and gravel, and crushed crushed. Metallic minerals accounted for 58% of the total nonfuel mineral value for the year, compared with 59% in 1985 and 1984, and 61% in 1983. Idaho was the sole domestic producer of antimony; it ranked first in garnet, silver, and vanadium production; second in lead production; third in the production of molybdenum; and fourth in the production of pumice. The State ranked 32d in the Nation in the value of nonfuel minerals produced in 1986, down substantially from the 22d ranking in 1985. Idaho ranked 37th in the value of its industrial mineral production in 1986.

**Trends and Developments.**—Silver, an historical mainstay of Idaho's mineral industry, suffered from drastically depressed prices throughout 1986. The price of silver averaged \$5.47 per ounce for the year; high-cost underground Coeur d'Alene District mines required a silver price of around \$7.00 per ounce to operate profitably. Four of the State's silver mines, two of which produced about 25% of the Nation's new silver in 1985, closed before midyear, and

most silver exploration and mine development programs were halted. Factors contributing to the depressed price for silver were the collapse of world oil prices, a disinflationary trend for commodity prices in general, and a weaker U.S. dollar. Despite mine closures, Idaho mines produced nearly 33% of the Nation's new silver in 1986, compared with almost 48% in 1985.

Reflecting a general downturn in the domestic phosphate industry, Idaho's phosphate production declined substantially in 1986. A lower demand from the agricultural sector and competition from foreign sources were factors leading to the closure of one fertilizer plant and a 6-week-long shutdown at another. The State's elemental phosphorus producers, however, enjoyed a relatively good year owing to a strong demand for finished products containing phosphorus.

Idaho's molybdenum production decreased in 1986, in response to a worldwide oversupply, shrinking domestic demand, and producers' stock inventories equivalent to several years' consumption. Additional production economies at Cyprus Minerals Co.'s Thompson Creek Mine, achieved by a month-long shutdown and a modified operating plan, kept the operation going in 1986.

Table 3.—Indicators of Idaho business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population ----- thousands	1,000	1,004	1,002
Total civilian labor force ----- do	463	465	468
Unemployment ----- percent	7.2	7.9	8.7
<b>Employment (nonagricultural):</b>			
Mining total <sup>1</sup> ----- thousands	4.2	3.8	2.9
Metal mining ----- do	2.8	2.6	1.9
Nonmetallic minerals except fuels <sup>2</sup> ----- do	1.3	1.2	.9
Oil and gas extraction <sup>2</sup> ----- do	.1	.1	.1
Manufacturing total ----- do	54.8	54.7	52.2
Stone, clay, and glass products ----- do	.9	.9	.8
Chemicals and allied products ----- do	3.5	3.6	3.3
Construction ----- do	14.6	15.1	14.6
Transportation and public utilities ----- do	19.1	19.2	18.6
Wholesale and retail trade ----- do	83.0	84.4	83.9
Finance, insurance, real estate ----- do	23.5	23.6	23.8
Services ----- do	62.5	65.0	67.5
Government and government enterprises ----- do	68.9	70.2	71.0
Total ----- do	330.5	336.0	334.5
<b>Personal income:</b>			
Total ----- millions	\$10,356	\$10,901	\$11,250
Per capita ----- do	\$10,361	\$10,859	\$11,223
<b>Hours and earnings:</b>			
Total average weekly hours, production workers ----- do	37.6	37.8	38.2
Mining ----- do	41.1	40.9	41.1
Total average hourly earnings, production workers ----- do	\$9.3	\$9.4	\$9.7
Mining ----- do	\$14.3	\$14.6	\$14.9
<b>Earnings by industry:<sup>4</sup></b>			
Farm income ----- millions	\$521	\$494	\$533
Nonfarm ----- do	\$6,969	\$7,360	\$7,516
Mining total ----- do	\$157	\$151	\$73
Metal mining ----- do	\$102	\$97	\$74
Nonmetallic minerals except fuels ----- do	\$43	\$37	( <sup>5</sup> )
Oil and gas extraction ----- do	\$12	\$17	\$17
Manufacturing total ----- do	\$1,300	\$1,359	\$1,347
Primary metal industries ----- do	\$5	\$2	\$2
Stone, clay, and glass products ----- do	\$21	\$21	\$19
Chemicals and allied products ----- do	\$112	\$123	\$125
Construction ----- do	\$655	\$676	\$699
Transportation and public utilities ----- do	\$574	\$597	\$589
Wholesale and retail trade ----- do	\$1,209	\$1,250	\$1,280
Finance, insurance, real estate ----- do	\$324	\$340	\$371
Services ----- do	\$1,386	\$1,542	\$1,664
Government and government enterprises ----- do	\$1,276	\$1,361	\$1,403
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>6</sup> ----- do	4,308	4,307	3,804
Value of nonresidential construction <sup>6</sup> ----- millions	\$205.3	\$251.9	\$171.7
Value of State road contract awards <sup>7</sup> ----- do	\$87.4	\$90.5	\$120.6
Shipments of portland and masonry cement to and within the State thousand short tons ----- do	277	237	292
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions	\$412.4	\$358.7	\$246.7
Value per capita ----- do	\$412	\$357	\$246

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; totals may not add because of inclusion of data from other sources.<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>3</sup>Data do not add to total shown because of independent rounding.<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>5</sup>Less than \$100,000.<sup>6</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>7</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

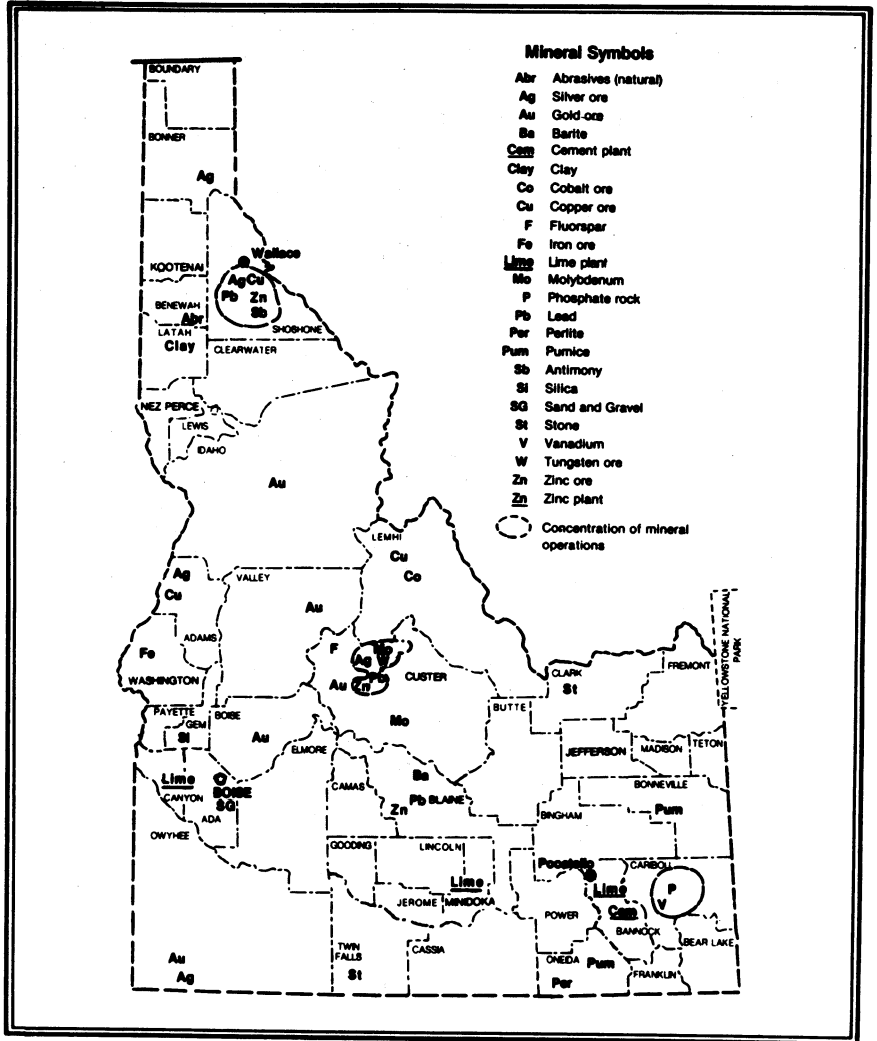


Figure 1.—Principal mineral-producing localities in Idaho.

Gold production in Idaho for 1986, which was nearly double the amount produced in 1985, constituted a bright spot in an otherwise gloomy mineral production picture. One significant new mine came on-stream, a major past producer was restarted, and several promising exploration projects were advanced to the permitting and development stages.

**Exploration Activities.**—The level of mineral exploration in Idaho increased in 1986, with gold deposits the primary targets. Exploration activity in the Coeur d'Alene silver mining region, however, decreased to the lowest level in recent years. A number of Canadian mining com-

panies were active in the State, and several announced development or mining plans during the year:

By yearend, a total of 73,978 active mining claims in Idaho had been recorded with the U.S. Bureau of Land Management (BLM). Counties with the highest levels of activity were Blaine, Boise, Custer, Idaho, Lemhi, and Shoshone; a summary of some of the more important exploration projects follows.

Ican Resources Ltd. evaluated an epithermal hot-springs-type gold deposit at the old Almaden mercury property east of Weiser in Washington County. An extensive drilling program outlined an 18-million-ton

open pit minable ore body grading 0.035 to 0.045 troy ounce of gold per ton. The near-surface ore body will require very little stripping, and the ore is amenable to a heap leach recovery method.

Atlanta Gold Corp. evaluated a potential open pit gold deposit in the Atlanta District, Elmore County. Drilling has indicated up to 14 million tons of ore grading 0.05 ounce of gold per ton. Preliminary plans were for a 250,000-ton-per-year heap leach operation using permanent leach pads and a 60-day leach cycle. Mine life was estimated to be 10 years.

Exploration activity for low-grade, heap-leachable gold deposits expanded in the Elk City region of Idaho County. The Amir Mines Ltd.-Normine Resources Ltd.-Glamis Gold Ltd. joint venture continued evaluation of the Buffalo Gulch and Friday properties near Elk City. A rotary drilling program at the North Buffalo Gulch zone indicated a 5-million-ton reserve grading 0.031 ounce of gold per ton; based on this drilling, 10,000 feet of development drilling was begun and column leach tests were started. The South Buffalo Gulch zone was defined by geological mapping and geochemical sampling. Work on the Friday property group indicated probable and possible reserves of 10 to 14 million tons grading 0.035 to 0.050 ounce of gold per ton.

United Gold Corp. announced plans to begin mining at the Ericson Reef Mine north of Elk City. Open pit reserves were estimated at 3 million tons grading 0.08 ounce of gold per ton. United has expended about \$1.1 million in exploration and plans to spend an additional \$6 to \$8 million to bring the mine into production. Alotta Resources Ltd. drilled on the Mineral Zone property west of Elk City; results indicated reserves of 758,000 tons grading 0.08 ounce of gold per ton. Other targets explored by Alotta included the Golden Eagle claims and a vein near the Four Mile Mine.

NeveX Gold Co. Inc. continued exploration at its Robinson-Dike claims near Dixie in Idaho County and reportedly was planning heap leach gold production in 1987.

**Employment.**—The closure of four silver mines and one phosphate mine and cutbacks at other operations resulted in a sharp decrease in Idaho's mineral sector employment for 1986. Metal mining employment declined to 1,960 workers, almost 25% below the 1985 employment figure; overall mining employment fell by nearly 26% to 2,900 workers.

Average weekly earnings in 1986 for Idaho's mineral industry production workers were \$609.50 for a workweek averaging 41 hours. Mineral industry wages again remained the highest for any production workers group in the State; average weekly earnings were up \$12.36 from those in 1985.

According to data supplied by the State of Idaho Department of Employment, average yearly wages for mineral industry production workers in the Coeur d'Alene District of Shoshone County increased to \$35,019.32 in 1986, compared with the annual average wage of \$33,459.70 paid in 1985. Reflecting the midyear episode of silver mine closures and cutbacks, Shoshone County mining employment decreased from 1,647 workers in January to 725 employees at yearend.

**Environment.**—The Environmental Protection Agency (EPA) began work on a cleanup of mining-related hazardous wastes in a 21-square-mile area in Shoshone County. The area included the dormant Bunker Hill smelter and minesite and the towns of Kellogg, Smelterville, and Wardner. Federally funded under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund), cleanup efforts in 1986 were restricted to a \$750,000 removal program for lead-contaminated soils in public parks and playing fields. The EPA Bunker Hill Site Remedial Investigation and Feasibility Study Work Plan, scheduled to have been released in August, was made public shortly after yearend.

The State of Idaho's \$50 million environmental cleanup suit against Bunker Hill and other Coeur d'Alene District mining companies was settled in June for \$4.5 million. The suit was filed in 1981 under the Superfund provisions that allowed States to attempt to recover damages for environmental cleanups.

**Legislation and Government Programs.**—The State of Idaho Department of Lands issued a summary of rules and regulations governing the issuance of riverbed mineral leases on State lands. The rules apply to the exploration and extraction of precious metals, minerals, and construction materials from placer deposits, and cover recreational mining, mining claim locations, rental and royalty fees, general lease terms, and bonding requirements.

In early 1986, the Idaho Division of Environment, Department of Health and Welfare, initiated the compilation of comprehensive cyanide leach mining regulations to regulate the cyanide extraction of precious



metals in the State. A technical advisory committee, including mining industry representatives, was organized to draft the regulations, which would specify the procedures for permitting and set minimum standards for operations using cyanide extraction. Work continued on the draft regulations at yearend.

An unsuccessful 1985 proposal for a large-scale interagency land exchange between the U.S. Forest Service and the BLM was revived in early 1986. The modified plan proposed the transfer of 2.8 million acres in Idaho from the BLM to the Forest Service, and the shifting of 1 million acres from Forest Service jurisdiction to the BLM. Under the exchange plan, the Forest Service would assume management of all public lands in the Idaho panhandle and near Salmon and Challis. The BLM would take over management of Federal land south of the Snake River between Twin Falls and Pocatello and east of Soda Springs. The Soda Springs District includes all of the active phosphate mines and most of the State's phosphate reserves. The proposed exchange, which reportedly would increase management efficiency, reduce personnel, and save up to \$1 million per year, was adamantly opposed by the mining industry, on the grounds that a change in Federal land management would destroy working relationships built up over the years. The proposal awaited enabling legislation at yearend.

The 1985 proposal by the Greater Yellowstone Coalition of environmental groups, to establish a 4-million-acre Greater Yellowstone Ecosystem buffer zone surrounding Yellowstone National Park, was opposed by a resolution approved in midyear by the Western States Legislative Conference's Land and Energy Committee. The resolution stated that the establishment of a Yellowstone Ecosystem would set a danger-

ous precedent that could adversely affect the economies of Western States that are strongly dependent on natural resource development. The ecosystem proposal, which would restrict all human activities, including mining, in the federally managed buffer zone, would affect producing phosphate mines and unmined phosphate reserves in the Caribou and Targhee National Forests in southeastern Idaho.

The Idaho Geological Survey (IGS) participated with the U.S. Geological Survey in the second year of a 4-year Conterminous United States Mineral Appraisal Program study of the Hailey 2° Quadrangle.

Progress on preparation of a 1:100,000-scale surficial geologic map of the State was made by the IGS, and its first annual report, summarizing yearly mining activity in the State, was released in 1986. Four Technical Reports were released, and a new series of one-page leaflet publications, called Geonotes, was begun during the year.

The Mining and Mineral Resources Institute of the University of Idaho received an allotment of \$276,463 from the U.S. Bureau of Mines in 1986; the institute has received a total of nearly \$2.5 million from the Bureau since inception of the program in 1978. During the year, the University of Idaho assisted the Virginia Polytechnic Institute in work on Mine Systems Design and Ground Control, which are the generic study areas assigned to the Idaho Institute.

The U.S. Department of Energy's Idaho National Engineering Laboratory was funded at \$3.4 million by the U.S. Bureau of Mines to continue a multiyear extractive metallurgy and materials technology research and development program in strategic and critical minerals.

Idaho received nearly \$2 million in 1986 from the BLM as receipts from the Mineral Leasing Act.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

**Antimony.**—Idaho was the only State in the Nation reporting antimony production in 1986. Sunshine Mining Co. recovered antimony as a byproduct from the electrolytic treatment of tetrahedrite, the principal silver-bearing ore mineral at the Sun-

shine Mine. Production, drastically reduced by closure of the Sunshine Mine in April, decreased 67% in quantity and 68% in value from that reported in 1985. Development work was carried out at the Antimony Rainbow Mine in Valley County, and at the Scorpion Extension property in Blaine County.

**Copper.**—Idaho's 1986 copper production, predominantly a byproduct from silver recovery in the Coeur d'Alene District of Shoshone County, decreased to about two-thirds of the quantity and value reported in 1985. Copper production was reported from seven mines in 1986; the largest producers were the Galena, Coeur, Sunshine, Lucky Friday, and Crescent Mines, which accounted for 99% of the total State copper output. The additional small production was reported from Custer County.

**Gold.**—Gold production in Idaho increased nearly 59% in quantity and about 84% in value from that achieved in 1985. The State rose in national ranking from 10th to 8th for the quantity and value of gold produced in 1986. Production was recorded from 10 lode mines during the year, compared with 11 operations reporting gold production in 1985. Pioneer Metals Corp.'s Stibnite Mine in Valley County was the State's first-ranked producer; in 1986 the heap leach operation produced 30,000 troy ounces of gold and 15,000 troy ounces of silver from 510,000 short tons of ore. The Stibnite Mine, which is Idaho's largest heap leach operation, was purchased early in the year by a consortium of Canadian firms from Mobil Corp. Pioneer Metals, the operating company, restarted the seasonal operation in June, after a 1-year hiatus in production. Since startup in late 1982, the Stibnite Mine has produced approximately 92,000 ounces of gold and 45,000 ounces of silver from about 1.34 million tons of ore.

NERCO Minerals Co.'s DeLamar gold-silver mine in Owyhee County was the State's second-ranked producer. According to the company's annual 10-K report, the open pit, closed-vat leach operation produced 28,000 ounces of gold and 1.7 million

ounces of silver from 850,000 tons of ore. Minesite exploration and engineering refinements added 115,000 ounces of gold and 6.7 million ounces of silver to the mine's reserves in 1986.

Coeur d'Alene Mines Corp. completed construction at its 3,500-ton-per-day Thunder Mountain Mine in Valley County, and commenced operations in September. The open pit, heap leach operation will have a 6-month operating season from May through October, and was expected to produce 27,000 ounces of gold per year for 5 years. The mine contained 1.79 million tons of minable proven reserves with an average grade of 0.095 ounce of gold per ton. The adjacent Lightning Peak area was explored during the year. In 1986, the company's annual report stated that 237,000 tons of ore averaging 0.077 ounce of gold per ton was processed, yielding 11,111 ounces of gold and 9,248 ounces of silver. An estimated \$18.7 million was expended in preproduction costs at Thunder Mountain.

Production was deferred again for at least a year at Geodome Resources Ltd.'s proposed Sunbeam Mine on Jordan Creek, Custer County. Detailed exploration work and mine planning were accomplished in 1986; construction was slated to begin in the summer of 1987.

U.S. Antimony Corp. (USAC) produced from its Estes Mountain gold-silver mine on Jordan Creek and from the Custer open pit on the Yankee Fork. USAC operated its 300-ton-per-day custom mill at Preachers Cove, processing its own ore, ore from the joint ventured Golden Maple Mining and Leaching Co. Valley Creek Mine near Stanley, and ore from the Atlantis Mining and Manufacturing Co. property near Hailey.

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

County	Mines producing		Material sold or treated <sup>1</sup> (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1984, total -----	13	2	1,627,020	W	W	18,869,186	\$153,607,626
1985, total -----	13	--	1,716,722	44,306	\$14,074,200	18,827,948	115,645,022
1986:							
Boise -----	--	1	--	W	W	--	--
Butte -----	1	--	W	W	W	W	W
Custer -----	2	--	W	W	W	W	W
Idaho -----	1	1	W	W	W	W	W
Owyhee -----	1	--	W	W	W	W	W
Shoshone -----	5	--	461,250	W	W	9,355,615	51,175,214
Valley -----	2	--	67,796	41,111	15,138,715	24,247	132,631
Total -----	12	2	<sup>1</sup> 1,945,960	<sup>2</sup> 70,440	<sup>2</sup> 25,938,825	<sup>2</sup> 11,206,851	<sup>2</sup> 61,301,475

See footnotes at end of table.

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

County	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1984, total -----	3,701	\$5,454,689	W	W	W	W	\$192,393,340
1985, total -----	3,551	5,241,792	33,707	\$14,168,756	W	W	W
1986:							
Boise -----	--	--	--	--	--	--	W
Butte -----	--	--	W	W	--	--	W
Custer -----	W	W	W	W	--	--	W
Idaho -----	--	--	--	--	--	--	W
Owyhee -----	--	--	--	--	--	--	W
Shoshone -----	W	W	W	W	351	\$294,020	60,109,374
Valley -----	--	--	--	--	--	--	15,271,346
Total -----	W	W	<sup>2</sup> 9,951	<sup>2</sup> 4,836,612	351	294,020	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Does not include gravel washed.<sup>2</sup>Includes items indicated by symbol W.**Table 5.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by class of ore or other source material**

Source	Number of mines	Material sold or treated <sup>1</sup> (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold <sup>2</sup> -----	4	678,871	41,326	25,979	W	W	--
Gold-silver -----	1	W	W	W	W	W	--
Silver -----	7	W	W	W	W	W	351
Total -----	12	<sup>3</sup> 1,945,960	W	<sup>3</sup> 11,206,851	W	<sup>3</sup> 9,951	351
Placer -----	2	--	W	--	--	--	--
Grand total --	14	<sup>3</sup> 1,945,960	<sup>3</sup> 70,440	<sup>3</sup> 11,206,851	W	<sup>3</sup> 9,951	351

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Does not include gravel washed.<sup>2</sup>Includes material that was leached.<sup>3</sup>Includes items indicated by symbol W.**Table 6.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:					
Cyanidation -----	68,733	W	--	--	--
Smelting of concentrates -----	W	9,468,054	W	W	351
Direct smelting of ore -----	--	W	--	W	--
Total -----	W	<sup>1</sup> 11,206,851	W	<sup>1</sup> 9,951	351
Placer -----	W	--	--	--	--
Grand total -----	<sup>1</sup> 70,440	<sup>1</sup> 11,206,851	W	<sup>1</sup> 9,951	351

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes items indicated by symbol W.

Big Buffalo Mining Co. operated the seasonal Big Buffalo Mine at Buffalo Hump, Idaho County, during the summer of 1986.

Metron Resources Corp. submitted an operating plan to the U.S. Forest Service for a proposed gold mine on Porphyry Creek in Lemhi County. The open pit mine would operate at 500 tons per day; a thiourea vat leach recovery process would be used.

Placer gold production was reported to the Bureau of Mines from two Idaho operations in 1986. The Ophir Creek Mine in Boise County recovered gold from an ancient river channel using small-scale mechanical and hand methods, and the Bald Eagle Mine operated a suction dredge on stream gravels in Idaho County. In addition, the IGS reported that at least six other placer operations were active in 1986. A total of 452 stream alteration permits for placer mining were issued by the Idaho Department of Water Resources in 1986; although the permits covered all placer operations, most were for small suction dredges operated as a hobby-type activity.

**Lead.**—Idaho retained its second ranking in lead production for 1986, although the quantity produced was a small fraction of the production in Missouri, the major producing State. Idaho's lead production, which was byproduct from silver mining, reflected the 1986 downturn in silver production, by decreasing 71% in quantity and 66% in value from that achieved in 1985. Although seven mines reported lead production in 1986, the bulk came from Hecla Mining Co.'s Lucky Friday Mine in Shoshone County, which shut down in April. The Lucky Friday closure, in turn, contributed to ASARCO Incorporated cutting back lead bullion production at its East Helena, MT, smelter, which processed Lucky Friday concentrates.

**Molybdenum.**—Reflecting a worldwide oversupply of molybdenum and consequent depressed prices, Idaho's 1986 molybdenum production decreased by 5% in quantity and 25% in value from that recorded in 1985. The third year production from Cyprus Minerals' Thompson Creek Mine, near Clayton in Custer County, was sufficient to retain Idaho's third ranking nationally for the quantity of molybdenum produced.

Cyprus Minerals' started the year on a 2-1/2-year-duration mine plan that eliminated preproduction stripping and called for closure of the operation by mid-1988. Production continued until October, when the mine and mill closed for 1 month to bal-

ance production and sales. In early November, the company announced that 110 of the 399-employee work force would be laid off in January 1987, that the 2-1/2-year mine plan would be scrapped, and that the operation would remain in production indefinitely at a reduced scale.

**Silver.**—Despite a year-long depression in silver prices, and the resultant closure of four Idaho silver mines, the State maintained its position as the Nation's top silver producer in 1986, accounting for 33% of domestic production. Idaho's 1986 silver production decreased by 41% in quantity and 47% in value, compared with that of 1985. Five mines in the Coeur d'Alene District of Shoshone County accounted for more than 83% of the total output reported from 12 mines in the State.

Asarco's Galena Mine near Wallace was the Nation's second-ranked silver producer in 1986, while its nearby Coeur Mine ranked third. Production from the Galena Mine decreased slightly from the 1985 level according to the company's annual report; nearly 4 million ounces of silver and 1,100 tons of copper were recovered from 201,000 tons of ore. Average ore grade was 20.5 ounces of silver per ton. The Galena and No. 3 shaft were connected on the 5200 level, and development work was concentrated on the 164 vein on that level during 1986.

Asarco's Coeur Mine set a new production record high of 2,743,000 ounces of silver and 1,200 tons of copper from 155,000 tons of ore, compared with 2,628,000 ounces of silver and 1,200 tons of copper from 151,000 tons of ore achieved in 1985. The Coeur Shaft was rehabilitated to the 3700 level; development work was concentrated on the 356 and 483 veins and on the new 384 vein. Asarco's Coeur d'Alene mines had the lowest operating costs in the district, enabling them to remain in production throughout 1986, despite silver prices averaging less than \$5.50 per ounce.

Low metal prices forced the closure in May of the American Silver joint venture exploration project. Asarco crews advanced the drift 174 feet in 1986 and were within 360 feet of the target Wire Silver vein at shutdown. The drive from the 3400 level of the Coeur Mine has advanced more than 5,100 feet since the project was started in 1979; an estimated \$13 million has been expended to date.

Hecla's Lucky Friday Mine slipped from its number one ranking nationally in 1985 to eighth in 1986. As credited in the compa-

ny's annual report, production for the year amounted to more than 1.3 million ounces of silver from 82,041 tons of ore, contrasted to a record high 4.7 million ounces of silver recovered from 276,817 tons of ore in 1985. Production at the Lucky Friday Mine was interrupted in March by a series of serious rock bursts, and operations were suspended indefinitely on April 11, owing to low silver prices.

The Lucky Friday Mine remained closed at yearend, except for experimental work on a new mining method called "underhand long wall stoping," designed to reduce rock bursts. In the new method, the vein is mined downward, ore is handled by ramps and ore passes located away from the vein, and mined-out stopes are backfilled with a thick concrete mixture.

Coincident with the closure of the Lucky Friday Mine, Hecla suspended all of its underground exploration programs in the Coeur d'Alenes. Work on the \$17.5 million Consolidated Silver project near Osburn was later resumed, but was permanently ended in August owing to disappointing results. The other terminated program was Hecla's 3-year underground drilling effort on adjacent Allied Silver-Lead Co. ground from the 5100 level of the Lucky Friday Mine.

Hecla dedicated its new \$6 million office complex in Coeur d'Alene on May 9. About 80 employees with an annual payroll of \$2.5 million worked at the new facility.

According to the company's annual report, production at Sunshine Mining's Sunshine Mine at Big Creek decreased drastically from that recorded in 1985, when the mine ranked second in the Nation in silver production. In 1986, the Sunshine Mine produced more than 1.15 million ounces of silver from 59,604 tons of ore; in 1985, production amounted to more than 4.71 million ounces from 218,509 tons of ore. The mine closed for 20 days on February 15 to reduce aboveground silver inventories; it reopened in March with a reduced work force. In early April, the company stated that all production would cease if union workers did not take a 35% wage cut. The union did not vote on the proposal. Operations at the mine were suspended on April 16, and it remained closed at yearend.

The Sunshine hydrometallurgical silver-copper refinery at Big Creek remained in production in 1986, processing custom doré, along with doré produced by Sunshine's

Silver Peak, NV, operation. During 1986, the refinery produced 2,507,388 ounces of fine silver, 37,274 ounces of fine gold, and 641,399 pounds of cathode copper. Sunshine Bullion Co., a wholly owned subsidiary of Sunshine Mining, processed 2,710,885 ounces of refined silver into assorted bars and coins in 1986. The fabricating and minting equipment is in Coeur d'Alene, ID.

Bunker Limited Partnership cut silver production early in the year at its Crescent Mine at Kellogg and was able to postpone closure until May, when the mine closed indefinitely. The 150-ton-per-day mill operated through June, when it was placed on standby.

Callahan Mining Corp. stopped drifting in February at its \$26.6 million Caladay exploration project east of the Galena Mine. A 1,699-foot drift on the 4900 level was completed before the suspension; it was projected to eventually connect to the Galena Mine workings. Underground diamond drilling continued all year, with work concentrated on extending existing holes north of the Caladay Shaft.

NERCO Minerals operated its DeLamar Mine without interruption in 1986. The 25,000-ton-per-day open pit gold-silver mine ranked sixth in the Nation in silver production for the year.

The Clayton Silver Mine, which had celebrated 50 years of operation in 1985, closed on May 24 despite salary and wage cuts and increased production from 225 to 350 tons per day.

The Silver Eagle Mining Co. reported silver production from its mine in Butte County during the year.

**Vanadium.**—Idaho was the leading vanadium-producing State in 1986; however, the quantity produced decreased 18% and the value was down by 20% from the levels achieved in 1985. Ferrophosphorus slag from two Idaho elemental phosphorus plants was processed for vanadium pentoxide and ammonium metavanadate by Kerr-McGee Chemical Corp. at Soda Springs in Caribou County.

**Zinc.**—Zinc production in Idaho, which was entirely byproduct from silver mining in 1986, declined 72% in quantity and 73% in value from that reported in 1985. The major zinc producer in the State was Hecla's Lucky Friday Mine, which suspended production in April owing to depressed silver prices.

**INDUSTRIAL MINERALS**

**Cement.**—Idaho's cement production was down slightly in 1986 from that recorded in 1985. Ash Grove Cement West Inc., at Inkoom in Bannock County, was the State's only cement producer. Finished portland cement was used by ready-mixed concrete companies (61%); other contractors (26%); concrete products manufacturers (6%); highway contractors (5%); and others, including building material dealers, government agencies; and miscellaneous customers (2%). A small amount of masonry cement was also produced. Ash Grove's two-kiln, wet-process plant used natural gas and bituminous coal for fuel and purchased electricity for energy. Raw materials used in cement manufacture were locally mined limestone and quartzite; gypsum and iron ore were shipped in from out of State.

**Clays.**—Idaho's 1986 clay production decreased 30% in quantity and about 17% in value from that reported in 1985. Bentonite, common clay, fire clay, and kaolin were mined from five pits in Benewah, Clark, and Latah Counties; the clays were used for adhesives, and in face brick, fire brick, and refractory grogs. The State's largest volume clay producer was Interpace Corp. in Benewah County.

**Garnet.**—In 1986, Idaho again ranked first in the Nation in garnet production. Garnet production at the Emerald Creek Garnet Milling Co. Inc. operation at Fernwood, Benewah County, increased more than 24% in quantity and value from 1985 levels. The company operated four dragline-dredge and washing plants on Emerald and Carpenter Creeks. The garnet was recovered by jigging and was trucked to the Fernwood plant for drying, crushing, sizing, and packaging. The company was the largest domestic producer of garnet. The product was sold for abrasives, as a filtration medium, for sandblasting, and as the cutting medium for high-pressure water-garnet steel cutting.

**Gem Stones.**—The value of 1986 gem stone production in Idaho increased to \$305,000, compared with \$175,000 for 1985; the State ranked eighth nationally in gem stone production for 1986. Aquamarine, gem quartz, jasper, precious opals, star garnets and topaz were mined in the State. There were a number of dig-for-fee operations in 1986.

Spencer Opal Mines, operator of the Deer Hunt Opal Mine in Clark County, changed

ownership during the year. The company mined opal for commercial sale and operated a fee-collecting area from mid-May to late September.

**Lime.**—Amalgamated Sugar Co.'s three lime plants in Canyon, Minidoka, and Twin Falls Counties accounted for all the State's 1986 lime production. Quicklime production for sugar manufacture decreased 4% in quantity and almost 19% in value from that of 1985.

**Perlite.**—Oneida Perlite Corp. mined perlite from a deposit on Wrights Creek; the material was processed at the company's Malad City plant in Oneida County. The expanded perlite, sold under the trade name Perlicor Products, was used for industrial fillers, in fireproofing, and as a filtering medium. The 1986 perlite production equaled that of 1985.

**Phosphate Rock.**—Idaho ranked third in the Nation for both quantity and value of marketable phosphate rock production in 1986, although the State accounted for only about 7% of the total domestic phosphate output for the year. Reflecting a general downturn in the domestic phosphate rock industry, Idaho's production decreased by nearly 31% in quantity and 47% in value from that reported in 1985.

The primary products processed from Idaho's phosphate rock were phosphoric acid used in fertilizer manufacture and elemental phosphorus used in industrial phosphate products. A major factor in the decline was reduced demand for agricultural purposes. Five open pit phosphate mines in the southeastern Idaho phosphate field in Bingham and Caribou Counties produced in 1986. Uses for Idaho phosphate rock in 1986 were wet-process phosphoric acid (51.5%), elemental phosphorus (41.3%), and normal superphosphate (7.2%).

Beker Industries Corp., after filing for chapter 11 bankruptcy in October 1985, closed its fertilizer plant at Conda in May, retaining a skeleton labor force to fill orders from stockpiles and to continue production of superphosphoric acid. Conda Partnership, a joint venture between Beker and Western Cooperative Fertilizers Ltd. of Calgary, Alberta, Canada, announced closure of the jointly owned calcining plant at Conda in August. Offers for the fertilizer operation were received from investor groups and others, but the plant remained unsold at yearend.

The J. R. Simplot Co. temporarily closed its Pocatello fertilizer plant and Smoky

**Canyon Mine** in June, to reduce excess inventories resulting from the soft fertilizer market. Mine and plant operations were restarted in August. Production from the FMC Corp.-Simplot jointly operated Gay Mine, on the Fort Hall Indian Reservation, continued during the shutdown; the mine was expanded onto the additional 2,300-acre tract leased in 1985. About 85% of the ore from the Gay Mine goes to FMC's Pocatello elemental phosphorus plant, and the remainder to Simplot's Pocatello operation.

FMC operated its elemental phosphorus plant throughout the year. A \$10 million major reconstruction of an electric reduction furnace was undertaken in 1986, and the company announced plans to spend \$15 million to install emission control equipment on its two large calciners over the next 3 years. FMC produces about 250 million pounds of elemental phosphorus per year.

Monsanto Co. operated its Soda Springs elemental phosphorus plant at 80% to 85% capacity until August, and then went to full capacity due to the closure of the company's Columbia, TN, operation. Monsanto mined phosphate rock at the Henry Mine in 1986.

Stauffer Chemical Co. shipped ore from the Wooley Valley Mine to its elemental phosphorus plant at Silver Bow, MT. Soda Springs Phosphate Inc. was ordered to halt production in June at its phosphate fertilizer plant until it could meet State air quality standards. Modification to the scrubber system enabled the 100-ton-per-day plant to resume production in July.

In December, Evergreen Resources proposed construction of a granular phosphate plant to be at Soda Springs. The facility would use tailings from Kerr-McGee's vanadium plant for feed.

N. A. Degerstrom Inc. announced plans to construct a \$1.5 to \$2 million plant to recover gallium and other materials, including potassium, silver, and zinc, from furnace stack dust ("treater dust") from the Monsanto elemental phosphorus plant at Soda Springs. The plant, which will be near the Monsanto operation, will be completed in mid-1987.

**Pumice.**—Idaho retained its fourth place ranking for pumice production in the Nation, although the 1986 production decreased by nearly 40% in quantity and 24% in value from that reported in 1985. Two operations, one in Bonneville County and the other in Oneida County, accounted for the State's production.

Hess Pumice Products, again the State's largest pumice producer, operated its Wrights Creek Mine near Malad in Oneida County. The processed pumice was used in lightweight building blocks, as an abrasive in soaps and cleaning compounds, and for industrial abrasive applications. Hess commenced production in April at a \$17 million automated pumice processing plant at Malad. The plant, which operated on a 2-shift-per-day basis, had a capacity of 20 tons of processed pumice per hour.

The State's second largest producer was Producers Pumice, from its Rock Hollow Mine near Ammon in Bonneville County; the material was used in lightweight concrete building block manufacture.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The 1986 output of construction sand and gravel in Idaho increased nearly 21% in quantity and almost 10% in value from that reported in 1984, when the last canvass was taken. Increases in the concrete aggregate, asphaltic concrete, and road base and coverings production categories reflected increased road building and repair throughout the State in 1986.

In 1986, seven counties—Ada, Bonneville, Canyon, Kootenai, Nez Perce, Power, and Twin Falls—accounted for 51% of the State's total construction sand and gravel tonnage. Major uses were for road base and coverings (43%), other uses (40%), and concrete aggregates (11%). More than 51% of Idaho's construction sand and gravel was transported by truck; the remainder was used on site.

**Table 7.—Idaho: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	612	\$2,178	\$3.56
Plaster and gunitite sands -----	10	53	5.30
Concrete products (blocks, bricks, pipe, decorative, etc.)-----	16	77	4.81
Asphaltic concrete aggregates and other bituminous mixtures -----	165	282	1.71
Road base and coverings -----	2,448	5,669	2.32
Fill -----	145	174	1.20
Other -----	3	14	4.67
Other unspecified <sup>1</sup> -----	2,309	6,383	2.76
<b>Total or average -----</b>	<b>5,708</b>	<b>14,830</b>	<b>2.60</b>

<sup>1</sup>Includes production reported without a breakdown by end use estimates for nonrespondents.

**Industrial.**—Industrial sand production in Idaho decreased 18% in quantity and nearly 12% in value from that reported in 1985. Unimin Corp. produced industrial sand at its operation in Emmett, Gem County. Industrial sand uses were in glass containers, for sandblasting sand, for filtration medium sand, in fiberglass manufacture, for roofing granules, and for other applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Lava Flow Products Inc. shipped 60,000 cubic yards of crushed scoria for

use in gas barbecues, landscaping, aquarium gravel, and road surfacing; the company operated a processing and packaging plant at Mountain Home in Elmore County.

**Dimension.**—Quartzite was quarried by three companies near Oakley in Cassia County for flagstone and decorative facing stone. Idaho Quartzite Corp. mined quartzite from the Amy-Ashley quarries; other stone producers in Oakley included Northern Stone Supply and Oakley Valley Stone.

The Marble Shop Inc. processed about 25,000 cubic feet of stockpiled travertine in 1986; the product was sold as facing for an office building in Atlanta, GA.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Spokane, WA.

<sup>2</sup>Associate director, Idaho Geological Survey, Moscow, ID.

**Table 8.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Antimony:</b> Sunshine Mining Co -----	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, plant	Shoshone.
<b>Cement:</b> Ash Grove Cement West Inc -----	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Surface mine and plant.	Bannock.
<b>Clays:</b> Clayburn Industries Ltd -----	3202 Beta Burnaby, BC, Canada	Surface mine ---	Latah.
A. P. Green Refractories Co., a subsidiary of USG Corp. -----	Box 158 Troy, ID 83871	---do -----	Do.
Interpace Corp -----	3502 Breakwater Ct. Hayward, CA 94545	---do -----	Benewah.
<b>Copper:</b> ASARCO Incorporated -----	Box 440 Wallace, ID 83873	Mine and mill ---	Shoshone.
Hecla Mining Co -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	---do -----	Do.
Sunshine Mining Co -----	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, refinery.	Do.
<b>Garnet:</b> Emerald Creek Garnet Milling Co. Inc ---	Route 4, Box 190 Fernwood, ID 83830	Pits and plant. ---	Benewah.



Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Gold:</b>			
Coeur d'Alene Mines Corp -----	505 Front Ave. Box 1 Coeur d'Alene, ID 83814	Surface mine and leach plant.	Valley.
Hecla Mining Co -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill. _ _	Shoshone.
NERCO Minerals Co -----	3230 Airport Way Fairbanks, AK 99701	Surface mine and mill.	Owyhee.
Pioneer Metals Corp -----	7275 Franklin Rd. Boise, ID 83709	Surface mine and leach plant.	Valley.
<b>Lead:</b>			
Clayton Silver Mines Inc -----	Box 890 Wallace, ID 83873	Mine and mill. _ _	Custer.
Hecla Mining Co -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	----do -----	Shoshone.
<b>Lime:</b>			
Amalgamated Sugar Co -----	First Security Bank Bldg. Ogden, UT 84402	Plants -----	Various.
<b>Molybdenum:</b>			
Cyprus Minerals Co -----	7200 South Alton Way Englewood, CO 80110	Surface mine and mill.	Custer.
<b>Perlite:</b>			
Oneida Perlite Corp -----	Box 162 Malad City, ID 83252	Surface mine and plant.	Oneida.
<b>Phosphate rock:</b>			
Conda Partnership -----	Box 37 Conda, ID 83230	----do -----	Caribou.
Monsanto Co -----	Box 816 Soda Springs, ID 83276	Surface mine ---	Do.
J. R. Simplot Co -----	Box 912 Pocatello, ID 83201	Surface mine and plant.	Bingham and Caribou.
Stauffer Chemical Co -----	Box 160 Montpelier, ID 83254	Surface mine ---	Caribou.
<b>Pumice:</b>			
Hess Pumice Products -----	Box 209 Malad City, ID 83252	Quarry and plant	Oneida.
Producers Pumice -----	6001 Fairview Ave. Boise, ID 83704	Quarry -----	Bonneville.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Atlas Sand and Rock, a div. of Eucon Corp.	3665 Snake River Ave. Lewiston, ID 83501	Pit -----	Nez Perce.
Central Premix Concrete Co -----	Box 336 Spokane, WA 99220	Pit -----	Kootenai.
Monroc Inc -----	Box 8388 Boise, ID 83707	Pits -----	Various.
Seubert Excavators Inc -----	Box 57 Cottonwood, ID 83522	----do -----	Idaho.
Western Construction Inc -----	Box 5403 Boise, ID 83705	----do -----	Various.
<b>Industrial:</b>			
Unimin Corp -----	258 Elm St. New Canaan, CT 06840	Pit -----	Gem.
<b>Silver:</b>			
ASARCO Incorporated -----	Box 440 Wallace, ID 83873	Mine and mill. _ _	Shoshone.
Bunker Limited Partnership -----	Box 29 Kellogg, ID 83837	---do -----	Do.
Clayton Silver Mines Inc -----	Box 890 Wallace, ID 83873	----do -----	Custer.
Hecla Mining Co -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	----do -----	Shoshone.
NERCO Minerals Co -----	3230 Airport Way Fairbanks, AK 99701	Surface mine and mill.	Owyhee.
Sunshine Mining Co -----	815 Park Blvd. Suite 100 Boise, ID 83702	Mine, mill, refinery.	Shoshone.
<b>Stone (dimension):</b>			
The Marble Shop Inc -----	3935 North Yellowstone Hwy. Idaho Fall, ID 83401	Quarry and plant	Bonneville.
<b>Vanadium:</b>			
Kerr-McGee Chemical Corp -----	Box 478 Soda Springs, ID 83276	Plant -----	Caribou.
<b>Zinc:</b>			
Hecla Mining Co -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814	Mine and mill. _ _	Shoshone.

# The Mineral Industry of Illinois

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

By James J. Hill<sup>1</sup>

Nonfuel mineral production in Illinois was valued at \$469.5 million in 1986, an increase of nearly \$10 million over the 1985 figure. Nationally, the State ranked 16th in nonfuel mineral production, after ranking 17th in 1985. Illinois was the Nation's leading producer of fluorspar, industrial sand, and tripoli and ranked fourth in sales of peat. In the metallic sector, the State ranked

fifth in production of lead and zinc. Crushed stone continued to be the leading mineral commodity in terms of value, accounting for 38% of the State's total mineral value. Other leading commodities, in decreasing order of value, were portland cement, construction sand and gravel, industrial sand, and lime.

Table 1.—Nonfuel mineral production in Illinois<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) - thousand short tons	1,997	\$82,622	2,101	\$86,211	2,118	\$83,783
Clays <sup>2</sup> -----do-----	253	940	265	876	283	1,092
Gem stones-----do-----	NA	<sup>e</sup> 15	NA	<sup>e</sup> 15	NA	15
Peat-----do-----	49	W	W	W	W	W
Sand and gravel:						
Construction-----do-----	25,969	72,477	<sup>e</sup> 26,600	<sup>e</sup> 77,000	27,867	82,523
Industrial-----do-----	4,100	52,197	4,056	56,915	4,039	52,133
Stone:						
Crushed-----do-----	<sup>e</sup> 48,500	<sup>e</sup> 191,600	41,044	164,117	<sup>e</sup> 44,200	<sup>e</sup> 179,600
Dimension-----do-----	<sup>r</sup> <sup>e</sup> 2	<sup>r</sup> <sup>e</sup> 107	2	107	<sup>e</sup> 2	<sup>e</sup> 107
Combined value of barite (1984-85), cement (masonry), clays (fuller's earth), copper (1985-86), fluorspar, lead, lime, silver, tripoli, zinc, and values indicated by symbol W-----	XX	72,010	XX	74,679	XX	70,272
Total-----do-----	XX	<sup>r</sup> 471,968	XX	459,920	XX	469,525

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fuller's earth; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Illinois in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adams	Stone (crushed).
Alexander	Tripoli.
Bond	Clays.
Boone	Stone (crushed).
Carroll	Do.
Christian	Do.
Clark	Do.
Clay	Do.
Coles	Do.
Cook	Lime, stone (crushed), peat.
De Kalb	Stone (crushed).
Douglas	Do.
Du Page	Do.
Fayette	Do.
Greene	Do.
Hancock	Do.
Hardin	Fluorspar, stone (crushed), zinc, barite, lead, copper, silver.
Henderson	Stone (crushed).
Henry	Do.
Iroquois	Do.
Jackson	Do.
Jersey	Do.
Jo Daviess	Do.
Johnson	Do.
Kane	Stone (crushed), stone (dimension).
Kankakee	Stone (crushed), clays.
Kendall	Stone (crushed).
Lake	Peat.
La Salle	Sand (industrial), cement, stone (crushed), clays.
Lee	Cement, stone (crushed).
Livingston	Stone (crushed), clays.
Logan	Stone (crushed).
McDonough	Do.
Madison	Do.
Mason	Sand (industrial).
Massac	Cement.
Menard	Stone (crushed).
Monroe	Do.
Montgomery	Do.
Ogle	Sand (industrial), stone (crushed).
Peoria	Stone (crushed).
Pike	Do.
Pulaski	Clays, stone (crushed).
Randolph	Stone (crushed).
Rock Island	Do.
St. Clair	Do.
Schuyler	Do.
Scott	Do.
Shelby	Do.
Stephenson	Do.
Union	Do.
Vermilion	Do.
Warren	Do.
Washington	Do.
Whiteside	Peat, stone (crushed).
Will	Stone (crushed).
Winnebago	Do.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Illinois business activity

	1984 <sup>†</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	11,524	11,537	11,552
Total civilian labor force -----	do.	5,608	5,668	5,686
Unemployment -----	percent	9.1	9.0	8.1
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup> -----	thousands	26.5	27.6	25.2
Coal mining -----	do.	15.6	15.7	14.6
Oil and gas extraction -----	do.	6.1	6.8	5.2
Manufacturing total -----	do.	997.0	970.7	925.2
Primary metal industries -----	do.	61.1	58.0	55.4
Stone, clay, and glass products -----	do.	25.6	24.5	23.3
Chemicals and allied products -----	do.	58.4	58.4	56.3
Petroleum and coal products -----	do.	9.3	8.7	8.3
Construction -----	do.	154.7	171.6	177.7
Transportation and public utilities -----	do.	278.3	280.9	277.6
Wholesale and retail trade -----	do.	1,148.1	1,166.9	1,184.7
Finance, insurance, real estate -----	do.	322.2	339.1	346.7
Services -----	do.	1,057.6	1,100.8	1,126.3
Government and government enterprises -----	do.	687.9	697.8	713.7
Total <sup>2</sup> -----	do.	4,672.3	4,755.3	4,776.9
<b>Personal income:</b>				
Total -----	millions	\$162,056	\$170,604	\$180,052
Per capita -----		\$14,063	\$14,788	\$15,586
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		40.6	40.6	40.9
Mining -----		43.9	41.3	40.7
Total average hourly earnings, production workers -----		\$10.1	\$10.4	\$10.7
Mining -----		\$14.1	\$14.3	\$14.7
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$1,433	\$1,733	\$1,674
Nonfarm -----	do.	\$115,694	\$122,560	\$129,935
Mining total -----	do.	\$1,296	\$1,388	\$1,307
Nonmetallic minerals except fuels -----	do.	\$164	\$178	\$174
Coal mining -----	do.	\$701	\$690	\$659
Oil and gas extraction -----	do.	\$430	\$519	\$473
Manufacturing total -----	do.	\$28,069	\$28,568	\$28,692
Primary metal industries -----	do.	\$2,059	\$1,999	\$1,961
Stone, clay, and glass products -----	do.	\$721	\$727	\$723
Chemicals and allied products -----	do.	\$1,992	\$2,079	\$2,133
Petroleum and coal products -----	do.	\$417	\$432	\$460
Construction -----	do.	\$6,608	\$7,077	\$7,677
Transportation and public utilities -----	do.	\$9,188	\$9,711	\$10,192
Wholesale and retail trade -----	do.	\$19,985	\$21,222	\$22,519
Finance, insurance, real estate -----	do.	\$8,951	\$9,816	\$11,228
Services -----	do.	\$26,007	\$28,455	\$31,008
Government and government enterprises -----	do.	\$15,173	\$15,931	\$16,871
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		30,180	38,719	51,876
Value of nonresidential construction <sup>4</sup> -----	millions	\$2,326.6	\$2,696.6	\$2,974.0
Value of State road contract awards <sup>5</sup> -----	do.	\$1,052.5	\$783.5	\$881.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	2,686	2,797	3,403
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$472.0	\$459.9	\$469.5
Value per capita -----		\$41	\$40	\$41

<sup>P</sup>Preliminary. <sup>†</sup>Revised.<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; totals may not add because of inclusion of data from other sources.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, pp. 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

Sources: U.S. Department of Commerce, Highway and Heavy Construction Magazine, Illinois Department of Employment Security in cooperation with the Bureau of Labor Statistics, U.S. Department of Labor, and U.S. Bureau of Mines.

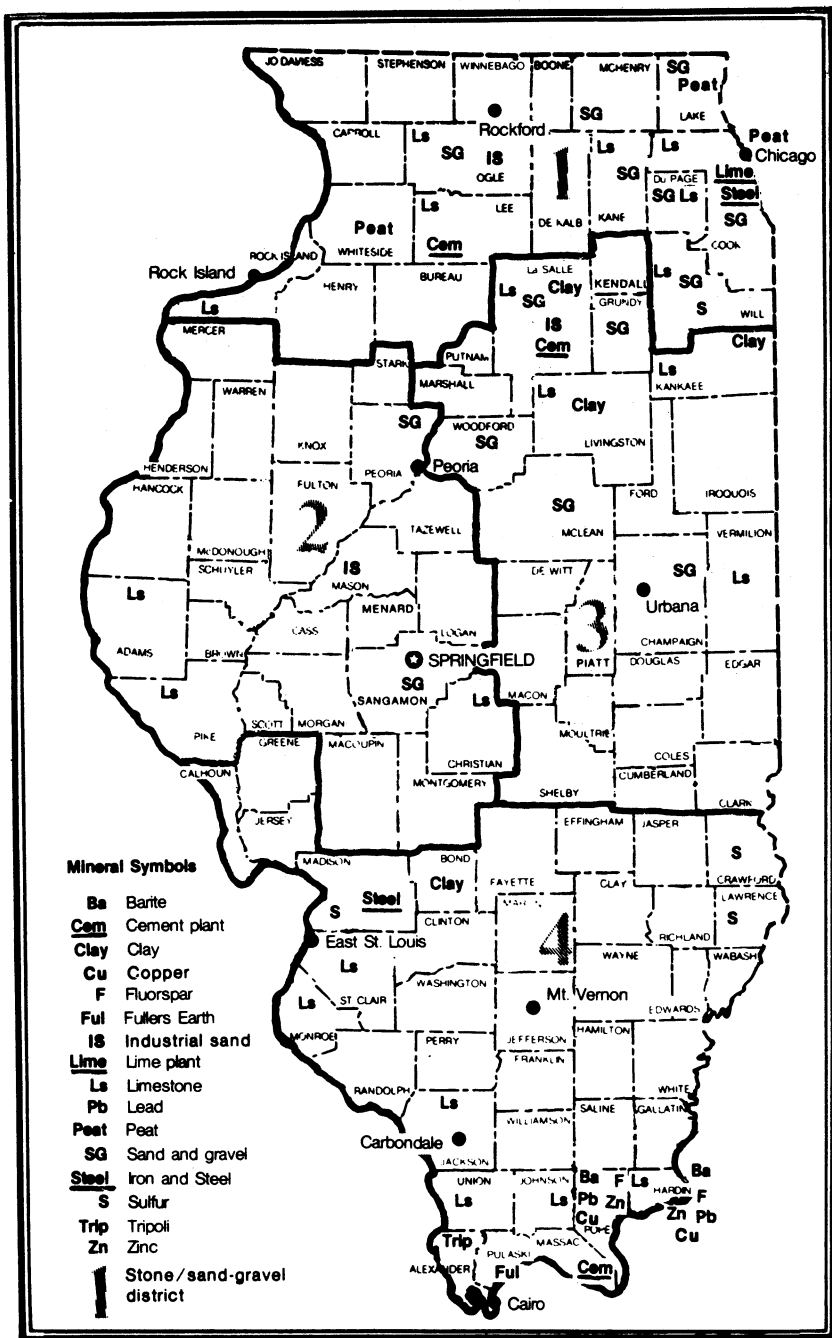


Figure 1.—Principal mineral-producing localities in Illinois.

**Employment.**—According to records of the Illinois Department of Employment Security, average monthly employment in mining and quarrying, excluding coal mining and oil and gas extraction, was 5,400 persons, compared with 5,100 workers in 1985. Average wages were \$11.69 per hour, compared with \$10.88 in 1985. Workers averaged 42.9 hours per week, compared with 46.3 hours in 1985.

Average monthly employment in the basic steel industry was 25,800 persons, up from the 24,700 workers reported in 1985. Average hourly earnings were \$13.38, slightly down from the \$13.42 reported in 1985. Steelworkers averaged 45.9 hours of work per week, compared with 41.4 hours in 1985.

No strikes were reported in the nonmetallic mining industry. Among the strikes reported for the metals industry were the USX Corp. work stoppage at its South Works Plant in Chicago, which began August 1 and continued through yearend, and a 5-week strike at the Amax Zinc Inc. refinery at Sauget.

**Exploration Activities.**—Most of the State's exploration and development activity concerned coal. Affidavits that 1,380 coal drill holes had been plugged were filed with the Illinois Department of Mines and Minerals in 1986. About 58 of these holes were thought to be exploration holes. Industrial minerals exploration efforts were sharply curtailed during the year. Ozark-Mahoning Co. operated two drilling rigs, one of them underground, in the vicinity of its Annabel Lee fluorspar mine, mainly for mine development purposes.<sup>2</sup>

**Legislation and Government Programs.**—One minerals-oriented bill was enacted into law during 1986. Public Act 84-1312 authorized the Illinois Department of Energy and Natural Resources to establish an Office of Coal Marketing to cooperate with the Illinois Department of Commerce and Community Affairs for the promotion and marketing of Illinois coal, both domestically and internationally.

The Illinois State Geological Survey (ISGS) was issued \$1.2 million in State bond

funds to purchase research equipment. Among the instruments obtained were an automated X-ray diffractometer, an X-ray fluorescence spectrometer, a gas chromatograph and mass spectrometer, and a scanning electron microscope. Funds were also used for a major upgrade of the ISGS computer. A 4-year cooperative program was undertaken with the U.S. Geological Survey and the State surveys of Indiana, Kentucky, and Missouri to assess the mineral potential of the Paducah 1° by 2° Quadrangle, which covers all of southern Illinois and parts of the adjacent States. All available geologic, tectonic, geophysical, and geochemical data for the area will be compiled and gaps filled in where needed. Ultimately, the researchers will assess the potential for mineral deposits in the area, including barite, fluorspar, other industrial minerals, base metals, coal, oil and gas, and water resources.

Northwestern University at Evanston was chosen by the American Iron and Steel Institute (AISI) to be the site of a new steel resource center that will focus on steel industry problems. Expected to open in early 1987, the center will concentrate on ways to improve management and technology in the steel industry. AISI committed a minimum of \$2.1 million in funding over the next 3 years to start the program. University officials hope to double this funding by attracting support from Federal agencies and major steel customers.

The U.S. Bureau of Mines distributed about \$517,000 in contracts and grants to Illinois firms, contractors, and research institutions in fiscal year 1986. Southern Illinois University—Carbondale, the State's Mining and Mineral Resources and Research Institute, received \$142,000 of these funds under Public Law 98-409 to assist in the training of engineers and scientists in mineral-related disciplines.

The Bureau's Twin Cities Research Center in Minneapolis, MN, and the University of Illinois, Urbana-Champaign, cooperated in studies that characterized subsidence damage over an abandoned coal mine near Hegeler, IL.<sup>3</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Abrasives (Manufactured).**—Two grades of silicon carbide were manufactured at Exolon-ESK Co.'s plant near Hennepin, Putnam County. Metallurgical silicon carbide was used in manufacturing cast iron and steel. Abrasive silicon carbide was used as a cutting agent in wire sawing, in grinding and polishing wheels, and as a refractory lining in blast furnaces. Production and attendant value increased 6% and 5%, respectively, in 1986.

**Barite.**—No production of barite was reported in 1986. Ozark-Mahoning, the State's only producer, shut down the barite circuit at its Rosiclare fluorspar mill in 1985 because of low demand and competition from foreign imports.

**Cement.**—Cement shipments accounted for about 18% of the State's total mineral value, ranking second to crushed stone sales. Masonry cement sales declined about 29% during the year, and portland cement sales increased slightly.

Cement was manufactured in La Salle, Lee, and Massac Counties by four companies operating seven kilns; one other kiln was idle throughout the year. Sales of masonry cement were reported by all companies except Illinois Cement Co. All companies produced gray portland cement Types I and II—general use and moderate heat, and all except Lone Star Industries Inc. produced Type III, high-early-strength. Most of the cement sales were made to ready-mixed concrete companies (82%), concrete product manufacturers (10%), and highway contractors (3%). The remaining sales were made to building material dealers, other contractors, and miscellaneous customers. Most of the cement manufactured in the State was transported to consumers by truck in bulk form.

Approximately 3.2 million short tons of raw materials was consumed in the manufacture of cement. This included 2.7 million tons of limestone, 181,000 tons of clay and shale, and 92,000 tons of gypsum, along with lesser quantities of clinker, fly ash, sand, and slag.

Cement shipments to and within Illinois included 3.3 million tons of portland cement and 89,000 tons of masonry cement. Compared with 1985 figures, this represented 590,000 tons more of portland and 16,000 tons more of masonry.

At the end of March, Missouri Portland Cement Co. closed its plant at Joppa and its

limestone quarry at Cave In Rock, affecting 152 and 32 employees, respectively. Subsequently, the plant was operated as a distribution center supplied by imported cement and cement from Davenport Cement Co.'s plant in Davenport, IA.

**Table 4.—Illinois: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	4	4
Production	2,073,069	2,139,187
Shipments from mills:		
Quantity	2,100,724	2,118,385
Value	\$86,210,707	\$83,783,379
Stocks at mills, Dec. 31	127,830	145,714

**Clays.**—Seven companies produced common clay and shale in Bond, Kankakee, La Salle, and Livingston Counties. Two companies produced fuller's earth in Pulaski County. La Salle County led the State in production of common clay and shale, with all the output used in cement manufacture. Sales of both common clay and shale and fuller's earth increased slightly during the year. About 42% of the State's clay production was used in the manufacture of face brick. Lesser quantities were used in cement manufacture, drain tile, sewer pipe, and miscellaneous products. Fuller's earth was used as an absorbent for oil and grease and pet litter.

**Fluorspar.**—Illinois continued to lead the Nation in production of fluorspar, with sales and attendant value increasing 18% and 14%, respectively. Ozark-Mahoning, the Nation's largest fluorspar producer, operated two mines in Hardin and Pope Counties and a flotation plant near Rosiclare, shipping both acid and metallurgical grades. Hastie Trucking & Mining Co. mined and shipped metallurgical-grade fluorspar at its operation near Cave In Rock. Inverness Mining Co., a former producer, dried imported fluorspar at its facilities near Cave In Rock for sale to the ceramic industry.

Ozark-Mahoning closed its Henson Mine in Pope County. In August, the company was presented with a certificate of appreciation from the Illinois Department of Mines and Minerals for operating 10 years and 2 million work hours without a fatal accident.

**Gem Stones.**—The Illinois Fluorspar District was the State's prime area for collecting mineral specimens, which included barite, calcite, fluorite, galena, and sphaler-

ite. Estimated value of specimens collected in 1986 was \$15,000.

**Gypsum (Calcined).**—National Gypsum Co. processed crude gypsum mined in nearby States at its wallboard plant in Waukegan, Lake County. Production increased 29% and attendant value 13% because of continuing strong demand from the construction industry.

**Lime.**—Illinois ranked seventh in both quantity and value of lime production among 34 producing States. Output and value dropped 15% and 18%, respectively, because of the decline in demand from the steel industry. Two companies, with operations in Cook County, accounted for the State's lime production. Marblehead Lime Co. operated plants at South Chicago and Thornton, and Vulcan Materials Co., a plant at McCook. Both companies produced hydrated lime and quicklime, with 96% of the product being quicklime. Lime consumption in Illinois from all domestic sources was 491,000 short tons of quicklime and 133,000 tons of hydrated lime. This was 28,000 tons less quicklime and 4,000 tons less hydrated lime than in 1985. Illinois ranked third in the consumption of hydrated lime, following Texas and Pennsylvania.

**Peat.**—Illinois ranked fourth of 22 States in peat sales. Five companies reported production in Cook, Lake, and Whiteside Counties in the northern part of the State. Sales and attendant value increased 12% and 14%, respectively. About 95% of the State's peat was sold in packaged form and 96% was for general soil improvement.

**Perlite (Expanded).**—Illinois ranked fifth in sales of expanded perlite among 32 producing States. Sales declined slightly during 1986, but value of sales increased about 10%, as the price per short ton increased \$25.62. Expanded perlite was used for agricultural purposes, cavity fill insulation, concrete and plaster aggregates, fillers, low-temperature insulation, and roof insulation.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Illinois ranked eighth nationally in the production of construction sand and gravel. Production was by 108 companies at 150 pits in 60 of the State's 102 counties. McHenry County had the most active pits with 15 and also led in total production with 7.8 million short tons, or 28% of the State's total production. Kane County ranked second with 3.3 million tons. Both counties are in the northeastern part of the State and supply gravel in the greater Chicago area. Three other Illinois counties also produced in excess of 1 million tons during the year.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 6 presents end-use data for construction sand and gravel produced in four Illinois districts depicted in figure 1.

**Table 5.—Illinois: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	6,048	\$18,757	\$3.10
Plaster and gunite sands -----	205	603	2.94
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	572	1,646	2.88
Asphaltic concrete aggregates and other bituminous mixtures -----	2,539	9,017	3.55
Road base and coverings <sup>1</sup> -----	3,254	11,387	3.50
Fill -----	2,984	6,717	2.25
Snow and ice control -----	171	475	2.78
Railroad ballast -----	W	W	6.65
Other -----	174	946	5.44
Other unspecified <sup>2</sup> -----	11,921	32,975	2.77
Total or average -----	<sup>3</sup> 27,867	82,523	2.96

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.



**Table 6.—Illinois: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	3,704	11,324	456	1,371	1,660	5,843	1,006	2,467
Asphaltic concrete aggregates and other bituminous mixtures-----	1,690	5,833	168	503	559	2,349	122	332
Road base and coverings <sup>2</sup> ----	2,010	6,747	198	559	766	3,131	280	950
Fill-----	1,718	3,494	163	206	599	1,603	504	1,414
Other <sup>3</sup> -----	283	995	--	--	58	403	3	24
Other unspecified <sup>4</sup> -----	8,395	23,275	1,084	3,267	1,966	5,370	475	1,064
Total-----	17,800	51,668	2,069	5,906	5,608	18,699	2,390	*6,250

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).<sup>2</sup>Includes road and other stabilization (cement and lime).<sup>3</sup>Includes railroad ballast and snow and ice control.<sup>4</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>5</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Illinois was the Nation's largest producer of industrial sand. Six companies produced sand from nine pits in Alexander, La Salle, Mason, and Ogle Counties. Most of the State's output was from La Salle County, where 3.7 million short tons was produced. Major sales of industrial sand were for glass containers, followed by foundry molding and core, flat glass, hydraulic fracturing, and sandblasting. Prices ranged from a low of \$4.19 per ton for unground fiberglass sand to \$100.00 per ton for ground fillers. About 61% of the State's production was shipped to consumers by truck, with lesser quantities shipped by rail and waterway.

Ottawa Silica Co., the Nation's fourth largest producer of industrial sand in 1985, was acquired by United States Borax & Chemical Corp. of Los Angeles, CA, during 1986. At yearend, U.S. Borax merged Ottawa Silica with Pennsylvania Glass Sand Corp. to become U.S. Silica Co., the Nation's largest producer of industrial sand.

**Slag—Iron and Steel.**—Three companies processed iron and steel slag from steel mills in Alton, Chicago, Granite City, and Peoria. Sales and value of sales increased 21% and 40%, respectively. Average value per short ton increased from \$3.27 to \$3.78. Most of the processed slag was used in road construction.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Production of crushed stone was estimated to be 44.2 million short tons, valued at \$179.6 million.

**Dimension.**—Production was estimated to have remained about the same as reported in 1985.

**Sulfur (Recovered).**—Sulfur was recovered at the oil refining operations of Marathon Oil Co., Shell Oil Co., UNOCAL Corp., and Mobil Oil Corp. in Crawford, Madison, and Will Counties. About 368,000 metric tons of sulfur was sold at an average value of \$99.28 per ton.

**Tripoli.**—Illinois ranked first of four States producing tripoli. Production was from Illinois Minerals Co. and Tammsco Inc. operations in Alexander County, the State's southernmost county. Output remained essentially the same as in 1985; value increased \$1.57 per short ton. Most tripoli sales were for fillers in paint, plastics, and rubber. Other uses were as an abrasive in buffing and polishing compounds, soap, and toothpaste.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. and Strong-Lite Products Corp. of Illinois exfoliated vermiculite mined in other States at their plants in Du Page and De Kalb Counties. Sales increased slightly during 1986; value increased \$20.50 per short ton. Major sales, in descending order by use, were for insulation (loose-fill and block), premixes (fireproofing and texturing), and aggregates (concrete and plaster). Other uses were for agricultural purposes and animal feed.

**METALS**

**Copper, Lead, Silver, and Zinc.**—All metals mined in Illinois were recovered as byproducts from Ozark-Mahoning's fluor-spar operations in Hardin County. Copper and silver output dropped 33% and 66%, respectively, in 1986. Lead and zinc production was up 40% and 117%, respectively.

**Iron Oxide Pigments (Finished).**—Illinois ranked first in quantity and second in value among 12 States producing finished iron oxide pigments. Three companies operated plants in Adams, St. Clair, and Sangamon Counties. Production and attendant value declined 7% and 2%, respectively, in 1986.

**Iron and Steel.**—Illinois ranked sixth of 11 States in shipments of pig iron in 1986, dropping from fifth place in 1985. Output dropped about 19%, to its lowest level since 1982. Several factors led to the decline in production. LTV Steel Co., the Nation's second largest steel producer, idled about one-half of its Chicago Works steelmaking capacity early in the year, laying off about 775 employees. The cutback reduced the plant's work force by about one-fourth, to 2,300 persons. LTV Corp., the parent of LTV Steel, filed for bankruptcy in July and shortly thereafter trimmed its steelmaking capacity even more, by idling several plants

nationwide. USX, the Nation's largest steel-maker, was faced with a nationwide work stoppage in August that lasted through yearend. This effectively terminated production at its South Chicago plant.

Several steel companies continued modernization programs to reduce costs and meet foreign competition. Northwestern Steel & Wire Co. of Sterling began a \$10.5 million renovation of its wire division that included expansion of the facility, replacement of antiquated equipment, and modernization of its 14-inch mill. Acme Steel Co. of Riverdale installed a \$7 million coil box at its mill that allowed the company to produce lighter gauge, higher strength steel in wider widths. National Steel Corp. dedicated a \$16 million ladle metallurgy station at its Granite City mill that was capable of handling 2 million short tons of steel per year. The station has a slag-skimming and argon-gas-injection system that allows steel to be manufactured with fewer impurities and a lower sulfur content.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Mining Engineering. Exploration 1986. V. 39, No. 5, May 1987, pp. 333-334.

<sup>3</sup>Marino, G. G., J. W. Mahar, L. R. Powell, and R. E. Thill. Ground Subsidence and Structural Damage Over an Abandoned Room-and-Pillar Coal Mine at Hegeler, IL. BuMines IC 9072, 1986, 24 pp.

**Table 7.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Abrasives (manufactured):</b>			
Exolon-ESK Co -----	Box 412 Hennepin, IL 61327	Plant -----	Putnam.
<b>Cement:</b>			
Dixon-Marquette Cement Inc., a subsidiary of Prairie Materials Sales Inc.	6428 Joliet Rd. Countryside, IL 60525	Quarry and plant	Lee.
Illinois Cement Co., a subsidiary of Centex Corp.	Box 442 La Salle, IL 61301	Quarry, clay pit, plant.	La Salle.
Lone Star Industries Inc., Cement and Construction Materials Group.	1 Greenwich Plaza Box 5050 Greenwich, CT 06836	-----do -----	Do.
Missouri Portland Cement Co., a division of Cementia Holdings AG.	Box 4288 Davenport, IA 52801	Plant -----	Massac.
Do -----	-----do -----	Quarry -----	Hardin.
<b>Clays:</b>			
Absorbent Clay Products Co. -----	Box 120 Anna, IL 62906	Pit and plant ---	Pulaski.
Lowe's Southern Clay Inc -----	348 South Columbia South Bend, IN 46624	-----do -----	Do.
Richards Brick Co. -----	234 Springer Ave. Edwardsville, IL 62025	-----do -----	Bond.
Streator Brick Systems Inc -----	West 9th St. Streator, IL 61364	-----do -----	Livingston.
<b>Fluorspar:</b>			
Hastie Trucking & Mining Co. -----	Cave In Rock, IL 62919 -----	Open pit -----	Hardin.
Ozark-Mahoning Co., a subsidiary of Pennwalt Corp. <sup>1</sup>	Box 57 Rosiclare, IL 62982	Underground mines and plant.	Hardin and Pope.
<b>Gypsum (calcined):</b>			
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	Plant -----	Lake.

See footnote at end of table.

Table 7.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Iron oxide pigments (finished):</b>			
Pfizer Pigments Inc -----	235 East 42d St. New York, NY 10017	Plant -----	St. Clair.
Prince Manufacturing Co -----	700 Lehigh St. Bowmanstown, PA 18030	--- do -----	Adams.
<b>Iron and steel:</b>			
Acme Steel Co -----	13500 South Perry Ave. Riverdale, IL 60627	--- do -----	Cook.
Granite City Div. of National Steel Corp.	Box 365 Granite City, IL 62041	Iron and steel furnaces.	Madison.
LTV Steel Co -----	1641 GH Republic Bldg. Cleveland, OH 44101	--- do -----	Cook.
<b>Lime:</b>			
Marblehead Lime Co., a subsidiary of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	Plants -----	Do.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	Plant -----	Do.
<b>Peat:</b>			
Hyponex Corp -----	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bog and plant.---	Whiteside.
Markman Peat Co -----	Route 3 Morrison, IL 61270	--- do -----	Do.
<b>Perlite (expanded):</b>			
Manville Corp -----	Route 6, Box 3429 Joliet, IL 60434	Plant -----	Will.
Silbrico Corp -----	6300 South River Rd. Hodgkins, IL 60525	--- do -----	Cook.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
R. A. Cullinan & Sons Inc -----	121 West Park St. Tremont, IL 61568	Pits and plants --	De Witt, McLean, Peoria, Taze- well, Woodford.
Elmhurst-Chicago Stone Co ---	Box 57 Elmhurst, IL 60126	--- do -----	Cook, Du Page, Kane.
McHenry Sand & Gravel Co. Inc	Box 511 McHenry, IL 60050	--- do -----	Boone and McHenry.
Material Service Corp., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	--- do -----	Grundy, Kane, McHenry.
Meyer Materials Co -----	Route 2, Box 56 Algonquin, IL 60102	--- do -----	Kane and McHenry.
Thelen Sand & Gravel Inc -----	28955 West Route 173 Antioch, IL 60002	Pit and plant ---	Lake.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	Pits and plants --	Champaign, Liv- ingston, McHen- ry, Macon.
<b>Industrial:</b>			
Manley Bros. of Indiana Inc ---	Box 538 Chesterton, IN 46304	Pit and plant ---	La Salle.
Unimin Corp -----	258 Elm St. New Canaan, CT 06840	Pits and plants --	Alexander, La Salle, Ogle.
U.S. Silica Co -----	Box 577 Ottawa, IL 61350	Pit and plant ---	La Salle.
Wedron Silica Co -----	Box 167 Wedron, IL 60557	--- do -----	Do.
<b>Slag—iron and steel:</b>			
Hckett Co -----	612 North Main St. Butler, PA 16001	Plants -----	Cook.
International Mill Service Co ---	1818 Market St. Philadelphia, PA 19103	--- do -----	Cook, Madison, Peoria.
St. Louis Slag Products Co. Inc., a division of Standard Slag Co.	Box 430 Granite City, IL 62040	Plant -----	Madison.
<b>Stone (crushed limestone, 1985):</b>			
Anna Quarries Inc -----	Box 180 Anna, IL 62906	Quarry and plant	Union.
Columbia Quarry Co -----	Box 128 Columbia, IL 62236	Underground mine, quarries, plants.	Johnson, Monroe, Pulaski, St. Clair, Union.
Material Service Corp., a subsidiary of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	--- do -----	Cook, Logan, Menard, Montgomery, St. Clair, Vermilion, Will.
Moline Consumers Co -----	313 16th St. Moline, IL 61265	Quarries and plants.	Adams, Hancock, Henry, La Salle, McDonough, Pike, Rock Island, War- ren.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	--- do -----	Clark, Cook, Iroquois, Kankakee, Livingston, Will.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sulfur (recovered):			
Mobil Oil Corp -----	Box 874 Joliet, IL 60434	Plant -----	Will.
Shell Oil Co -----	Box 262 Wood River, IL 62095	---do -----	Madison.
UNOCAL Corp -----	1650 East Golf Rd. Schaumburg, IL 60196	---do -----	Will.
Tripoli:			
Illinois Minerals Co., a subsidiary of Georgia Kaolin Co.	2035 Washington Ave. Cairo, IL 62914	Underground and open pit mines and plant.	Alexander.
Tammsco Inc -----	Box J Tamms, IL 62988	Underground mine and plant.	Do.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	6051 West 65th St. Bedford Park, IL 60638	Plant -----	Du Page.
Strong-Lite Products Corp. of Illinois	1120 Oak St. De Kalb, IL 60115	---do -----	De Kalb.

<sup>1</sup>Also copper, lead, silver, and zinc.



# The Mineral Industry of Indiana

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

By James J. Hill<sup>1</sup>

In 1986, Indiana ranked 26th nationally in nonfuel mineral production and had output valued at \$305 million, a slight increase over the \$303 million value reported in 1985. The State led the Nation in shipments of masonry cement and ranked second and third in sales of dimension stone and peat, respectively. In the metals sector, Indiana was the leading producer of pig iron and ranked fourth in output of primary aluminum.

In order of value, the leading nonmetallic

mineral commodities produced in the State were portland cement, crushed stone, and construction sand and gravel. Together, they accounted for 75% of the State's total nonfuel mineral value. Demand for these commodities was stimulated by residential construction activity, for which building permits increased 29% during the year, and highway construction spending, which quadrupled between fiscal years 1986 and 1987.

Table 1.—Nonfuel mineral production in Indiana<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons ..	W	W	W	W	395	\$22,936
Portland ----- do. ....	W	W	W	W	2,136	92,327
Clays ----- do. ....	<sup>2</sup> 653	<sup>2</sup> \$2,085	740	\$2,776	744	3,044
Gem stones ----- do. ....	NA	<sup>1</sup>	NA	<sup>1</sup>	NA	1
Peat ----- thousand short tons ..	61	1,358	54	W	79	W
Sand and gravel:						
Construction ----- do. ....	16,071	44,744	<sup>1</sup> 18,600	<sup>1</sup> \$55,800	19,642	61,232
Industrial ----- do. ....	194	1,129	182	1,209	193	1,490
Stone:						
Crushed ----- do. ....	<sup>2</sup> 26,700	<sup>2</sup> \$99,400	<sup>2</sup> 23,384	<sup>2</sup> \$81,119	<sup>2</sup> 22,600	<sup>2</sup> \$76,500
Dimension ----- do. ....	<sup>1</sup> \$163	<sup>1</sup> \$17,113	<sup>1</sup> 169	20,186	<sup>1</sup> 191	<sup>1</sup> \$20,252
Combined value of abrasives (natural), clays (fire clay, 1984), gypsum, lime, stone (crushed marl, 1985-86), and values indicated by symbol W -----	XX	130,250	XX	141,863	XX	27,566
Total -----	XX	<sup>1</sup> 296,080	XX	302,954	XX	305,348

<sup>1</sup>Estimated. <sup>2</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fire clay; value included with "Combined value" figure.

<sup>3</sup>Excludes marl; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Indiana in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adams	Stone (crushed).
Allen	Stone (crushed), peat.
Bartholomew	Stone (crushed).
Blackford	Do.
Carroll	Do.
Cass	Cement, stone (crushed), clays.
Clark	Do.
Clay	Clays.
Crawford	Stone (crushed).
Decatur	Do.
Delaware	Do.
Dubois	Clays.
Elkhart	Stone (crushed).
Fountain	Clays.
Franklin	Stone (crushed), stone (dimension).
Grant	Stone (crushed).
Hamilton	Stone (crushed), peat.
Harrison	Stone (crushed).
Howard	Do.
Huntington	Stone (crushed), clays.
Jackson	Clays.
Jasper	Stone (crushed).
Jay	Do.
Jennings	Do.
Lagrange	Do.
Lake	Lime.
La Porte	Peat, sand (industrial).
Lawrence	Cement, stone (dimension), stone (crushed).
Madison	Stone (crushed), peat.
Marion	Stone (crushed).
Martin	Gypsum.
Miami	Stone (crushed).
Monroe	Stone (dimension), stone (crushed).
Morgan	Clays, stone (crushed).
Newton	Stone (crushed).
Orange	Stone (crushed), abrasives.
Owen	Stone (crushed).
Porter	Stone (crushed).
Pulaski	Sand (industrial).
Putnam	Stone (crushed).
Randolph	Cement, stone (crushed), clays, stone (dimension).
Ripley	Stone (crushed).
Rush	Do.
Scott	Stone (crushed), stone (dimension).
Shelby	Stone (crushed).
Sullivan	Do.
Switzerland	Do.
Vermillion	Clays.
Warren	Sand (industrial).
Washington	Stone (crushed).
Wayne	Do.
Wells	Stone (crushed), peat.
White	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Indiana business activity

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	5,493	5,500	5,504
Total civilian labor force -----	do.	2,621	2,728	2,750
Unemployment -----	percent	8.6	7.9	6.7
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	10.2	10.1	8.9
Nonmetallic minerals except fuels <sup>1</sup> -----	do.	2.8	2.9	3.0
Coal mining <sup>1</sup> -----	do.	6.6	W	5.3
Manufacturing total -----	do.	620.5	609.8	602.8
Primary metal industries -----	do.	80.2	74.7	66.4
Stone, clay, and glass products -----	do.	18.9	18.9	19.1
Chemicals and allied products -----	do.	29.7	29.3	29.2
Petroleum and coal products -----	do.	4.1	4.1	3.8
Construction -----	do.	79.4	87.0	96.4
Transportation and public utilities -----	do.	105.6	109.3	112.5
Wholesale and retail trade -----	do.	488.6	505.9	526.2
Finance, insurance, real estate -----	do.	103.3	105.5	110.5
Services -----	do.	386.6	408.1	427.9
Government and government enterprises -----	do.	328.1	332.9	342.6
Total -----	do.	2,122.3	2,168.6	<sup>2</sup> 2,227.7
<b>Personal income:</b>				
Total -----	millions	\$65,062	\$68,377	\$72,294
Per capita -----		\$11,845	\$12,431	\$13,136
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		41.7	40.9	41.5
Total average hourly earnings, production workers -----		\$10.4	\$10.7	\$10.8
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$916	\$798	\$1,016
Nonfarm -----	do.	\$46,373	\$49,171	\$51,954
Mining total -----	do.	\$454	\$486	\$446
Nonmetallic minerals except fuels -----	do.	\$64	\$70	\$71
Coal mining -----	do.	\$303	\$298	\$261
Oil and gas extraction -----	do.	\$87	\$119	\$113
Manufacturing total -----	do.	\$17,294	\$17,784	\$18,108
Primary metal industries -----	do.	\$2,868	\$2,801	\$2,625
Stone, clay, and glass products -----	do.	\$485	\$495	\$529
Chemicals and allied products -----	do.	\$1,060	\$1,114	\$1,167
Petroleum and coal products -----	do.	\$183	\$189	\$180
Construction -----	do.	\$2,563	\$2,835	\$3,109
Transportation and public utilities -----	do.	\$3,355	\$3,504	\$3,673
Wholesale and retail trade -----	do.	\$7,002	\$7,443	\$7,970
Finance, insurance, real estate -----	do.	\$2,042	\$2,202	\$2,533
Services -----	do.	\$7,631	\$8,453	\$9,233
Government and government enterprises -----	do.	\$5,880	\$6,320	\$6,722
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		18,998	23,016	29,686
Value of nonresidential construction <sup>4</sup> -----	millions	\$1,122.7	\$1,445.0	\$1,306.1
Value of State road contract awards <sup>5</sup> -----	do.	\$309.3	\$329.9	\$367.2
Shipments of portland and masonry cement to and within the State -----	thousand short tons	1,324	1,429	1,677
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$296.1	\$303.0	\$305.3
Value per capita -----		\$54	\$55	\$55

<sup>p</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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



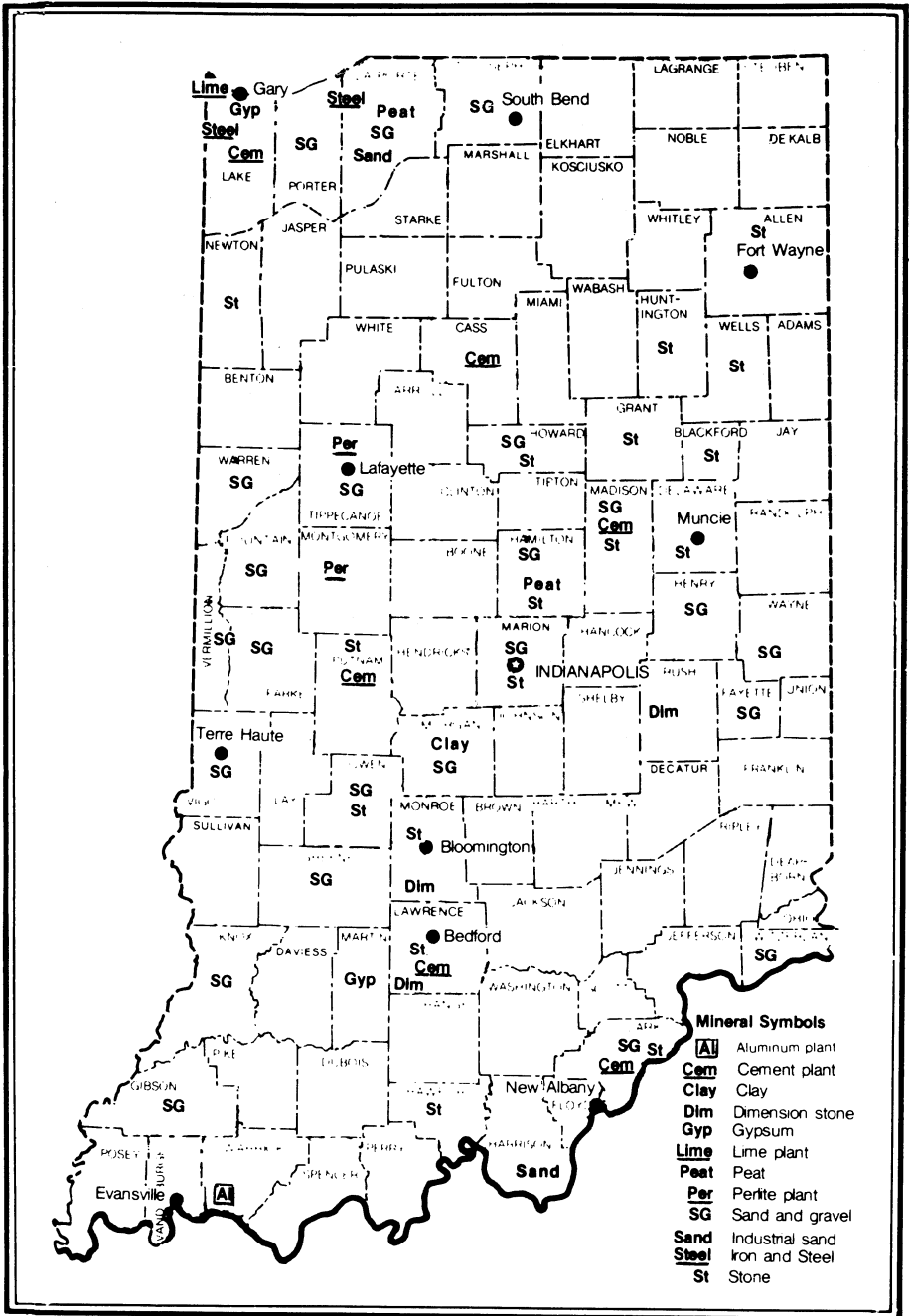


Figure 1.—Principal mineral-producing localities in Indiana.

**Employment.**—Indiana's Employment Security Division reported that employment in mining and quarrying averaged 8,900 workers in 1986, down from the 10,100 persons employed in 1985. Average hourly earnings were \$14.22, and average number of hours worked per week was 42.9. The State's steel mills employed an average of 36,300 persons in 1986 compared with 42,600 workers in 1985. The drop in employment in the steel sector was primarily related to the strike against USX Corp. Steelworkers averaged 41.3 hours per week in 1986; earnings averaged \$15.26 per hour.

**Exploration Activities.**—In a core-drilling program designed to determine deep coal resources in southwestern Indiana, the Indiana Geological Survey (IGS) encountered a thick section of Seelyville Coal near Evansville. The deposit consisted of two seams totaling 11 feet thick at a depth of 744 feet, making it one of the thickest coal beds known in the Illinois Basin. Private coal companies trimmed exploration budgets during the year because of falling coal prices, while several companies increased exploration activities for limestone deposits because of the continued strong demand for dimension stone. Quarry sites were also investigated for crushed stone resources.

Eastern Shale Research Corp. performed core drilling and test blasting at a site it selected in Scott County for a retort. The company was studying the feasibility of developing a shallow, horizontal in situ retort to produce synthetic hydrocarbons from the upper part of the New Albany Shale.<sup>2</sup>

**Legislation and Government Programs.**—Indiana's Mineral Extraction Mine Reclamation Act (Senate bill 214) became effective on July 1, 1986. This law required the IGS to prepare maps of significant aggregate deposits in urban and urbanizing areas. The maps would be made available to local zoning and planning officials, who must take the mineral deposits into consideration before deciding whether to permit a land use incompatible with mineral extraction. Permits also were required for new and existing aggregate operations. The law

established a mineral extraction mine reclamation fund, set bonding fees, and required reclamation plans.

Senate bill 268 established a mine subsidence insurance program, whereby owners of residential and commercial property would be allowed the opportunity to purchase insurance coverage to protect against damage to structures from subsidence caused by underground coal mines. Startup costs for the program were funded by a Federal grant of almost \$2.7 million until the program becomes self-sustaining.

The IGS, in Bloomington, continued disseminating information on the State's geology and mineral resources to the public, industry, and government. Ongoing studies included investigating coal resources, mapping subsidence-prone areas, and documenting shoreline processes in the Indiana Dunes area to resolve environmental concerns. At midyear, the IGS came under the stewardship of a new director, following the retirement of its previous leader.

In fiscal year 1986, the Division of Reclamation within the Department of Natural Resources received \$15.9 million in Federal funds for programs it regulated under the Surface Mining Control and Reclamation Act of 1977. At yearend, the division had 3 clay, 69 surface coal, and 2 underground coal active mining permits under its jurisdiction.

The U.S. Bureau of Mines granted \$230,000 in fiscal year 1986 to the Mining and Mineral Research Institute of Purdue University in West Lafayette under Public Law 98-409. Under the act, funds are channeled to research institutions to assist in the training of engineers and scientists in mineral-related disciplines. Personnel with the Bureau's Twin Cities Research Center in Minneapolis, MN, assisted Indiana's Division of Reclamation in determining site-specific criteria for good blasting practices in an area of current surface mining over abandoned underground mines. Research personnel were also involved in development of a plan to determine the extent of sinkhole problems in a shallow mined-out area near Boonville in southern Indiana.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Abrasives.**—Hindustan Whetstone Co. continued to mine sandstone at a quarry near Orleans, Orange County, to supply its plant in Bedford, where it manufactures a line of cuticle removers, table coasters, and sharpening stones. Production increased substantially during the year because of successful product marketing.

Annealed and chilled iron shot and grit were manufactured by US Abrasives at its plant in Tippecanoe in Marshall County. Both production and value declined substantially during the year.

**Cement.**—Nationally, Indiana ranked 1st and 10th, respectively, in shipments of masonry and portland cement. Production and value increased significantly during 1986 because of the continuing high demand from the construction industry. In terms of value, cement was the leading mineral commodity produced in the State, accounting for 38% of the State's total nonfuel mineral value. Three companies produced both masonry and portland cement at four plants in Cass, Clark, Lawrence, and Putnam Counties. All companies produced Types I and II—general-use and moderate-heat portland cements (which accounted for 90% of the quantity sold) and Type III—a high-early-strength portland cement. White cement sales were also reported at all plants. Lehigh Portland Cement Co. continued to produce aluminous cement, also known as calcium aluminate cement, at its Buffington Station plant at Gary, Lake County.

Cement sales were to ready-mixed companies (70%), concrete product manufacturers (15%), building material dealers (6%), highway contractors (6%), and other contractors and miscellaneous customers (3%). Most of the cement sold was shipped to customers by truck in bulk form. Cement shipments to and within Indiana during 1986 included 1,580,000 short tons of portland cement and 97,000 tons of masonry cement. This represented 227,000 tons more of portland cement and 21,000 tons more of masonry cement shipped than in 1985.

**Clays.**—Although output of common clay and shale increased only slightly, value of production increased nearly 10%, to over \$3 million, surpassing values attained in the past 10 years. Eleven companies had operations in 10 of the State's 92 counties. Morgan County led the State's production, followed by Clark and Putnam Counties. Most of the output was used in the manufacture of cement, followed by face brick

and lightweight aggregate for use in the manufacture of concrete block. Other uses included filler for animal feed, electrical porcelain, pottery, and asphalt tile.

The new ceramic tile facility of KPT Inc., at Bloomfield, began production early in the year. The state-of-the-art manufacturing plant uses local clays in its product.

**Fluorspar (Processed).**—National Briquette Corp. of East Chicago, Lake County, continued to fabricate briquets of imported fluorspar for use by the steel industry as flux. Total consumption of fluorspar by all consumers in Indiana climbed from 37,000 short tons in 1985 to 43,000 tons in 1986. The gain was attributed to increased use by the steel industry.

**Gypsum.**—Nationally, Indiana ranked seventh in the production of both crude and calcined gypsum. Although output increased slightly during 1986, value per short ton of crude and calcined gypsum dropped \$1.31 and \$4.63, respectively, because of competitive pricing. Two firms, National Gypsum Co. and USG Corp., mined crude gypsum from underground mines at Shoals, Martin County, in southcentral Indiana. Both firms calcined gypsum at minesite plants. USG also operated a wallboard plant at East Chicago that utilized crude gypsum from a company mine in Michigan. Of the 63 mines producing crude gypsum in the United States in 1986, National Gypsum's mine ranked eighth and USG's mine ranked fifth in production. USG's Shoals plant ranked seventh nationally among 72 calcining plants. Most gypsum was used in the manufacture of wallboard; lesser quantities were used in cement, in plasters, and for soil conditioning.

During the year, USG's Shoals Mine was awarded the "Sentinels of Safety" award for the "underground nonmetal" category after having compiled more than 175,000 injury-free worker hours in 1985.

**Lime.**—Lime production dropped 37% during 1986 to its lowest level in 10 years. The use of limestone-enhanced taconite pellets in the steelmaking process reduced the demand for lime by the steel industry. Two firms produced lime during the year: Inland Steel Co. operated a plant at Indiana Harbor, and Marblehead Lime Co. operated a plant at Buffington. Both plants received limestone from quarries in Michigan and converted it to quicklime for the steel industry.

**Peat.**—Nationally, Indiana ranked third in quantity and value of peat sales. Peat was harvested in Allen, Hamilton, La Porte,

and Madison Counties by five companies. Millburn Peat Co. Inc.'s operation in La Porte County was the State's largest. Sales and value of sales increased 44% and 61%, respectively, during 1986. Peat was used mainly for general soil improvement and as a potting soil ingredient, with lesser sales for golf courses and other uses. Most peat sold was in packaged form.

**Perlite (Expanded).**—Indiana ranked 10th of 32 States in sales of expanded perlite. Four companies expanded crude perlite obtained from out-of-State sources at plants in Martin, Montgomery, and Tippecanoe Counties. Sales declined about 16% during the year. Expanded perlite was used as aggregate in plaster, block insulation, filler, and filter aids.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is

surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Indiana ranked 14th of 50 States in the production of sand and gravel used in construction. Output and value of sales increased 6% and 10%, respectively, because of a continuing high level of construction activity. Production was recorded for 83 companies operating 135 pits in 59 of the State's 92 counties. Production in excess of 1 million short tons was reported for Hamilton, Marion, Switzerland, Tippecanoe, and Vigo Counties, and their combined output accounted for 41% of the State's production. Most of the State's construction sand and gravel was shipped to consumers by truck.

**Table 4.—Indiana: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,685	\$15,158	\$3.24
Plaster and gunite sands -----	89	355	3.99
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	911	2,326	2.55
Asphaltic concrete aggregates and other bituminous mixtures -----	1,913	6,328	3.31
Road base and coverings <sup>1</sup> -----	1,126	3,552	3.15
Fill -----	1,581	3,443	2.18
Snow and ice control -----	234	642	2.74
Other -----	1,130	3,624	3.21
Other unspecified <sup>2</sup> -----	7,973	25,804	3.24
Total or average -----	19,642	61,232	3.12

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Industrial.**—Sand used for industrial purposes was produced by four companies from five pits in Fountain, Harrison, La Porte, and Porter Counties. Production increased about 6% during the year. Average value per short ton increased \$1.09. About 57% of the State's output (109,370 tons) was for use as foundry molding and core sand; the remainder was used in glass manufacturing, refractories, and other miscellaneous uses.

During 1986, Manley Bros. of Indiana Inc. began mining the former Unimin Corp. industrial sand site in Michigan City, La Porte County. The firm purchased the operation from Unimin in December 1985.

**Slag—Iron and Steel.**—Iron and steel slag shipments by Indiana's three processors, who operated plants in Howard, Lake, and Porter Counties, totaled 3.7 million

short tons, valued at \$10.0 million in 1986. The State ranked second among 28 States in total slag sales. Slag was used as asphalt and concrete aggregates, road base material, railroad ballast, filler media, and for septic tank absorption beds.

The Levy Co. Inc. began operating a new slag processing plant at LTV Steel Co.'s mill in East Chicago during the year.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Nationally, Indiana ranked 19th in the quantity of crushed stone produced and 21st in value. Production was estimated to be 22.6 million short tons, valued at \$76.5 million.

In July, Koppers Co. of Pittsburgh, PA, purchased The France Stone Co. of Toledo, OH. France Stone, through its subsidiary, May Stone & Sand Inc., operated two quarries at Fort Wayne in Allen County. France Stone also had two operations in Putnam County: a quarry at Cloverdale and a fine-grinding plant at Greencastle. Limestone from the Cloverdale Quarry was trucked to Greencastle where it was ground for filler and for animal feed.

*Dimension.*—Indiana ranked second of 36 States in the production of dimension stone and was the Nation's largest producer of dimension limestone. Production in 1986 was estimated to be nearly 191,000 short tons, valued at \$20.3 million.

Indiana Limestone Co. Inc. and B. G. Hoadley Quarries Inc. began testing a new saw in their quarries that used a diamond impregnated polypropylene belt for cutting. The saw was reported to be less expensive to operate and faster cutting than a wire saw.

*Sulfur (Recovered).*—Amoco Oil Co. recovered elemental sulfur at its refining operations at Whiting in Lake County. Sales declined about 4% during 1986, and average value per metric ton declined about 24%.

## METALS

*Aluminum.*—Indiana ranked fourth of 14 States in primary aluminum production. The State's sole producer was the Aluminum Co. of America with operations near Evansville in Warrick County, southwestern Indiana. Both production and value increased nearly 7% during the year despite an 11-week strike by the plant's 2,700 union workers. Salaried personnel kept the mills operating during the strike period.

In 1986, the company added electromagnetic casting facilities to the Warrick plant as part of its nationwide modernization program. Final engineering studies on a 64-inch continuous coil coating line, which will be used to coat aluminum can "end stock," also were completed. The coil coating line

was expected to be operational in mid-1987.

Advanced Aluminum Products Inc. began installing a second line at its minimill in Hammond, which produces sheet aluminum from scrap. Plant capacity would be doubled, to 80 million pounds per year, and several new jobs created.

*Beryllium-Copper Alloys.*—Cabot Corp. sold its beryllium-copper alloy cold strip mill in Elkhart to Inco Alloys International Ltd., a unit of International Nickel Co. Inc. of Canada. Cabot also divested its High Technology Materials Div. in Kokomo, which produced superalloys; the independent firm will be called Haynes International Inc.

*Iron and Steel.*—Indiana continued to be the leading steel producer in the Nation although the State's steel industry was beset with difficulties throughout the year. Pig iron production dropped to 14.0 million short tons from 15.7 million tons in 1985. This was the lowest output reported since the recession of 1982. Value of shipments declined to \$2.5 billion from the \$3.2 billion reported for 1985. Steel companies continued reducing capacity by closing unproductive, outdated facilities. Several companies restructured during the year. All the major steel companies, except USX, received concessions from their union workers in new contract agreements that averted prolonged strikes. USX's steelworkers began a nationwide strike on August 1 and remained off the job through yearend, effectively terminating the company's production for the rest of the year. LTV Corp., the Nation's second largest steel producer, filed for protection under chapter 11 of the Federal Bankruptcy Code on July 17th. The company took immediate steps to idle several unprofitable plants and facilities and remained under the supervision of a Federal bankruptcy judge through yearend.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Mining Engineering. Exploration 1986. V. 39, No. 5, May 1987, p. 334.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives:</b>			
<b>Manufactured:</b>			
US Abrasives -----	Box 155 Tippecanoe, IN 46570	Plant -----	Marshall.
<b>Natural:</b>			
Hindustan Whetstone Co --	Box 862 Bedford, IN 47421	Quarry ----- Plant -----	Orange. Lawrence.
<b>Aluminum:</b>			
Aluminum Co. of America ----	Warrick Operations Box 10 Newburgh, IN 47630	Smelter and fabricat- ing plant.	Warrick.
<b>Cement:</b>			
Coplay Cement Co., a subsidiary of Société des Cimento Fran- caise:	Box 35750 Louisville, KY 40232		
Logansport plant <sup>1 2</sup> -----	-----	Plant, quarry, clay pit	Cass.
Speed plant <sup>1 2</sup> -----	-----	do -----	Clark.
Lehigh Portland Cement Co., a subsidiary of Heidelberg Zement AG:	Box 1882 Allentown, PA 18105		
Anderson terminal -----	-----	Distribution terminal	Madison.
Buffington Station plant -----	-----	Plant -----	Lake.
Mitchell plant -----	-----	Plant and quarry	Lawrence.
Lone Star Industries Inc., Green- castle plant. <sup>1 2</sup> -----	Box 5050 Greenwich, CT 06836	Plant, quarry, clay pit	Putnam.
<b>Clays:</b>			
General Shale Products Corp. ---	Box 96 Mooresville, IN 46158	Pits and plant -----	Morgan.
Hydraulic-Press Brick Co., Haydite Div.	Brooklyn, IN 46111 -----	Pit and plant -----	Do.
Yellow Banks Clay Products Inc. <sup>1</sup>	Box 29 Huntingburg, IN 47542	Pits, quarry, plant ---	Dubois.
<b>Fluorspar (processed):</b>			
National Briquette Corp. -----	5222 Indianapolis Blvd. East Chicago, IN 46312	Plant -----	Lake.
<b>Gypsum:</b>			
National Gypsum Co. -----	2001 Rexford Rd. Charlotte, NC 28211	Underground mine and plant.	Martin.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	do ----- Plant -----	Do. Lake.
<b>Iron and steel:</b>			
Bethlehem Steel Corp -----	Bethlehem, PA 18016 -----	Mill (integrated) -----	Porter.
Continental Steel Corp -----	Box 5049 Kokomo, IN 46902	Minimill -----	Howard.
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	Mill (integrated) -----	Lake.
LTV Steel Co -----	3001 Dickey Rd. East Chicago, IN 46312	do -----	Do.
National Steel Corp., Midwest Steel Div.	U.S. 12 Portage, IN 46368	Mill (rolling) -----	Porter.
USX Corp., Gary Works Div ---	1 North Broadway Gary, IN 46402	Mill (integrated) -----	Lake.
<b>Lime:</b>			
Inland Steel Co., a subsidiary of Inland Steel Industries Inc.	3210 Watling St. East Chicago, IN 46312	Plant -----	Do.
Marblehead Lime Co., a subsid- iary of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	do -----	Do.
<b>Peat:</b>			
Hyponex Corp. -----	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bogs and plant -----	Hamilton.
Millburn Peat Co. Inc -----	Box 236 La Porte, IN 46350	do -----	La Porte.
<b>Perlite (expanded):</b>			
Chemrock Corp -----	Box 5465 Lafayette, IN 47903	Plant -----	Tippecanoe.
Grefco Inc -----	Box 48 Crawfordsville, IN 47933	do -----	Montgomery.
National Gypsum Co. -----	2001 Rexford Rd. Charlotte, NC 28211	do -----	Martin.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	do -----	Do.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
American Aggregates Corp --	Drawer 160 Greenville, OH 45331	Pits and plants -----	Hamilton, Marion, Wayne.
Hilltop Basic Resources Inc --	630 Vine St. Cincinnati, OH 45202	Pit and plant -----	Switzerland.
Irving Materials Inc -----	Box 369, Rural Route 5 Greenfield, IN 46140	Pits and plants -----	Fayette, Hamilton, Henry, Madison, Wayne.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27622	do -----	Clark, Howard, Marion, Vermillion, Vigo.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Construction—Continued			
OK Sand & Gravel Co. Inc. --	5320 South Belmont Indianapolis, IN 46217	Pit and plant -----	Marion.
Rogers Group Inc. -----	Box 849 Bloomington, IN 47402	Pits and plants -----	Fountain, Greene, Knox, Mor- gan, Owen, Warren.
Vulcan Materials Co. <sup>1</sup> -----	Box 7497 Birmingham, AL 35253	-----do -----	La Porte, Parke, St. Joseph, Tippecanoe.
Industrial:			
Card Industrial Sand Corp. --	Box 1316 New Albany, IN 47150	Pit and plant -----	Harrison.
Crisman Sand Co. Inc. -----	6480 Melton Rd. Portage, IN 46368	Pits and plants -----	Porter.
Harrison Steel Castings Co. -	Box 60 Attica, IN 47918	Pit and plant -----	Fountain.
Manley Bros. of Indiana Inc. -	Box 538 Chesterton, IN 46304	Pits and plants -----	La Porte.
Slag:			
Iron and steel:			
The Levy Co. Inc. <sup>1</sup> -----	Box 540 Portage, IN 46368	Plants -----	Lake and Porter.
Steel:			
Heckett Co. -----	Box 1071 Butler, PA 16001	Plant -----	Lake.
International Mill Service Co.	1818 Market St. Philadelphia, PA 19103	Plants -----	Howard and Lake.
Stone (1985):			
Crushed:			
Limestone:			
American Aggregates Corp.	Drawer 160 Greenville, OH 45331	Quarries and plants --	Hamilton, Marion, Owen.
The France Stone Co. --	Box 1928 Toledo, OH 43603	-----do -----	Allen and Putnam.
Irving Bros. Stone & Gravel Inc.	Box 300, Rural Route 13 Muncie, IN 47302	-----do -----	Blackford, Delaware, Grant, Hunting- ton, Wells.
Martin Marietta Aggre- gates.	Box 30013 Raleigh, NC 27622	-----do -----	Elkhart, Howard, Madison, Marion, Putnam.
Mulzer Crushed Stone Inc.	Box 248 Tell City, IN 47586	Quarries, mine, plants	Crawford.
Rogers Group Inc. -----	Box 849 Bloomington, IN 47402	Quarries and plants --	Lawrence, Monroe, Newton, Putnam.
Marl:			
Vernon M. Kaufman --	Route 1 Topeka, IN 46571	Pit -----	Lagrange.
M. W. Wolkins -----	Box 332 Union, MI 49130	Pit -----	Elkhart.
Dimension:			
Limestone:			
Bybee Stone Co. -----	Box 968 Bloomington, IN 47402	Quarry and plant ---	Monroe.
Elliot Stone Co. Inc. ---	Box 743 Bedford, IN 47421	-----do -----	Lawrence.
Evans Quarries Inc. ---	Box 711 Bedford, IN 47421	-----do -----	Do.
B. G. Hoadley Quarries Inc.	Box 1224 Bloomington, IN 47402	Quarries and plants --	Lawrence and Monroe.
Independent Limestone Co.	6001 South Rockport Rd. Bloomington, IN 47401	Quarry and plant ---	Monroe.
Indiana Limestone Co. Inc.	Box 72 Bedford, IN 47421	Quarries and plants --	Lawrence and Monroe.
Reed Quarries Inc. -----	Box 64 Bloomington, IN 47402	Quarry and plant ---	Monroe.
Victor Oolitic Stone Co. -	Box 668 Bloomington, IN 47402	-----do -----	Do.
Sulfur (recovered):			
Amoco Oil Co. -----	Box 710 Whiting, IN 46394	Elemental sulfur recov- ered as a byproduct of oil refining.	Lake.

<sup>1</sup>Also crushed stone.<sup>2</sup>Also clays.

# The Mineral Industry of Iowa

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

By Leon E. Esparza<sup>1</sup> and Robert M. McKay<sup>2</sup>

Iowa's nonfuel mineral production in 1986 was valued at about \$249 million, an increase of 9% over that reported in 1985. This increase was a significant rebound from the 3-year low reported in 1985. Nationally, Iowa ranked 30th in nonfuel mineral production. Most of the State's nonfuel mineral production was used in the construction industry. The increased production value was attributed to falling interest rates, which resulted in increased residen-

tial construction activity. A total of 5,472 residential units were authorized in 1986, 282 permits more than were issued in 1985. Value of nonresidential construction, however, dropped 8% from that of 1985. Road construction value, as measured by contract awards, and which also reflects consumption levels of some nonfuel minerals, was up almost 70% when compared with the 1985 figures.

Table 1.—Nonfuel mineral production in Iowa<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons...	42	\$3,260	39	\$3,372	48	\$3,199
Portland ----- do.....	1,730	92,699	1,618	77,890	1,819	86,984
Clays ----- do.....	623	2,695	503	2,450	486	1,421
Gem stones ----- do.....	NA	W	NA	*1	NA	20
Gypsum ----- thousand short tons...	1,527	12,421	1,639	13,682	1,826	12,602
Peat ----- do.....	11	400	11	415	14	381
Sand and gravel (construction) ----- do.....	13,882	37,027	*12,000	*30,500	14,511	40,418
Stone (crushed) ----- do.....	*23,800	*100,000	23,657	94,496	*23,400	*98,000
Combined value of other industrial minerals and values indicated by symbol W.....	XX	<sup>†</sup> 5,246	XX	5,211	XX	5,707
Total -----	XX	<sup>†</sup> 253,748	XX	228,017	XX	248,732

\*Estimated. <sup>†</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



Table 2.—Nonfuel minerals produced in Iowa in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adair	Stone (crushed).
Adams	Do.
Allamakee	Do.
Appanoose	Do.
Benton	Do.
Black Hawk	Do.
Bremer	Do.
Buchanan	Do.
Butler	Do.
Cass	Do.
Cedar	Do.
Cerro Gordo	Cement, stone (crushed), clays.
Chickasaw	Stone (crushed).
Clarke	Do.
Clayton	Do.
Clinton	Do.
Dallas	Clays.
Davis	Stone (crushed).
Decatur	Do.
Delaware	Do.
Des Moines	Gypsum, stone (crushed).
Dubuque	Stone (crushed), stone (dimension).
Fayette	Stone (crushed).
Floyd	Do.
Franklin	Do.
Fremont	Do.
Hamilton	Do.
Hancock	Do.
Hardin	Do.
Harrison	Do.
Henry	Do.
Howard	Do.
Humboldt	Do.
Jackson	Do.
Jasper	Do.
Jefferson	Do.
Johnson	Do.
Jones	Stone (crushed), stone (dimension).
Keokuk	Stone (crushed).
Lee	Do.
Linn	Stone (crushed), peat.
Louisa	Stone (crushed).
Madison	Stone (crushed), clays.
Mahaska	Stone (crushed).
Marion	Stone (crushed), gypsum.
Marshall	Stone (crushed).
Mills	Do.
Mitchell	Do.
Monroe	Do.
Montgomery	Do.
Muscatine	Stone (crushed), peat.
Page	Stone (crushed).
Pocahontas	Do.
Folk	Cement, stone (crushed).
Pottawattamie	Stone (crushed).
Poweshiek	Do.
Scott	Cement, lime, stone (crushed), clays.
Story	Stone (crushed).
Tama	Do.
Taylor	Do.
Union	Do.
Van Buren	Do.
Wapello	Stone (crushed), clays.
Washington	Stone (crushed).
Webster	Gypsum, stone (crushed).
Winnebago	Peat.
Winneshiek	Stone (crushed).
Woodbury	Clays.
Worth	Stone (crushed), peat.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Iowa business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands .....	2,904	2,881	2,851
Total civilian labor force -----	do .....	1,412	1,412	1,432
Unemployment -----	percent .....	7.0	8.0	7.0
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup> -----	thousands .....	2.0	2.1	1.9
Nonmetallic minerals except fuels <sup>1</sup> -----	do .....	1.8	1.8	1.7
Manufacturing total -----	do .....	211.9	204.7	201.3
Primary metal industries -----	do .....	7.9	7.3	6.6
Stone, clay, and glass products -----	do .....	4.8	4.4	4.7
Chemicals and allied products -----	do .....	6.6	6.4	6.3
Construction -----	do .....	38.7	36.6	35.9
Transportation and public utilities -----	do .....	51.5	52.0	51.8
Wholesale and retail trade -----	do .....	277.1	276.6	276.7
Finance, insurance, real estate -----	do .....	61.8	62.8	62.9
Services -----	do .....	227.0	232.5	238.5
Government and government enterprises -----	do .....	204.5	206.8	208.0
Total <sup>2</sup> -----	do .....	1,074.7	1,074.2	1,077.0
<b>Personal income:</b>				
Total -----	millions .....	\$34,687	\$36,046	\$38,053
Per capita -----	do .....	\$11,943	\$12,510	\$13,348
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do .....	40.2	40.2	40.5
Mining -----	do .....	46.2	44.2	41.9
Total average hourly earnings, production workers -----	do .....	\$10.2	\$10.3	\$10.3
Mining -----	do .....	\$8.0	\$8.3	\$8.4
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions .....	\$1,587	\$1,988	\$2,848
Nonfarm -----	do .....	\$21,807	\$22,460	\$23,242
Mining total -----	do .....	\$88	\$106	\$101
Nonmetallic minerals except fuels -----	do .....	\$43	\$44	\$41
Manufacturing total -----	do .....	\$5,478	\$5,423	\$5,462
Primary metal industries -----	do .....	\$285	\$261	\$266
Stone, clay, and glass products -----	do .....	\$120	\$110	\$120
Chemicals and allied products -----	do .....	\$197	\$199	\$195
Petroleum and coal products -----	do .....	\$6	\$5	\$5
Construction -----	do .....	\$1,205	\$1,228	\$1,265
Transportation and public utilities -----	do .....	\$1,646	\$1,646	\$1,678
Wholesale and retail trade -----	do .....	\$3,995	\$4,064	\$4,145
Finance, insurance, real estate -----	do .....	\$1,330	\$1,398	\$1,537
Services -----	do .....	\$4,353	\$4,743	\$5,051
Government and government enterprises -----	do .....	\$3,485	\$3,681	\$3,817
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do .....	7,198	5,190	5,472
Value of nonresidential construction <sup>4</sup> -----	millions .....	\$461.1	\$445.5	\$407.8
Value of State road contract awards <sup>5</sup> -----	do .....	\$233.0	\$207.0	\$351.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons .....	1,218	1,089	1,059
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions .....	\$253.7	\$228.0	\$248.7
Value per capita -----	do .....	\$87	\$79	\$87

<sup>P</sup>Preliminary. <sup>T</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

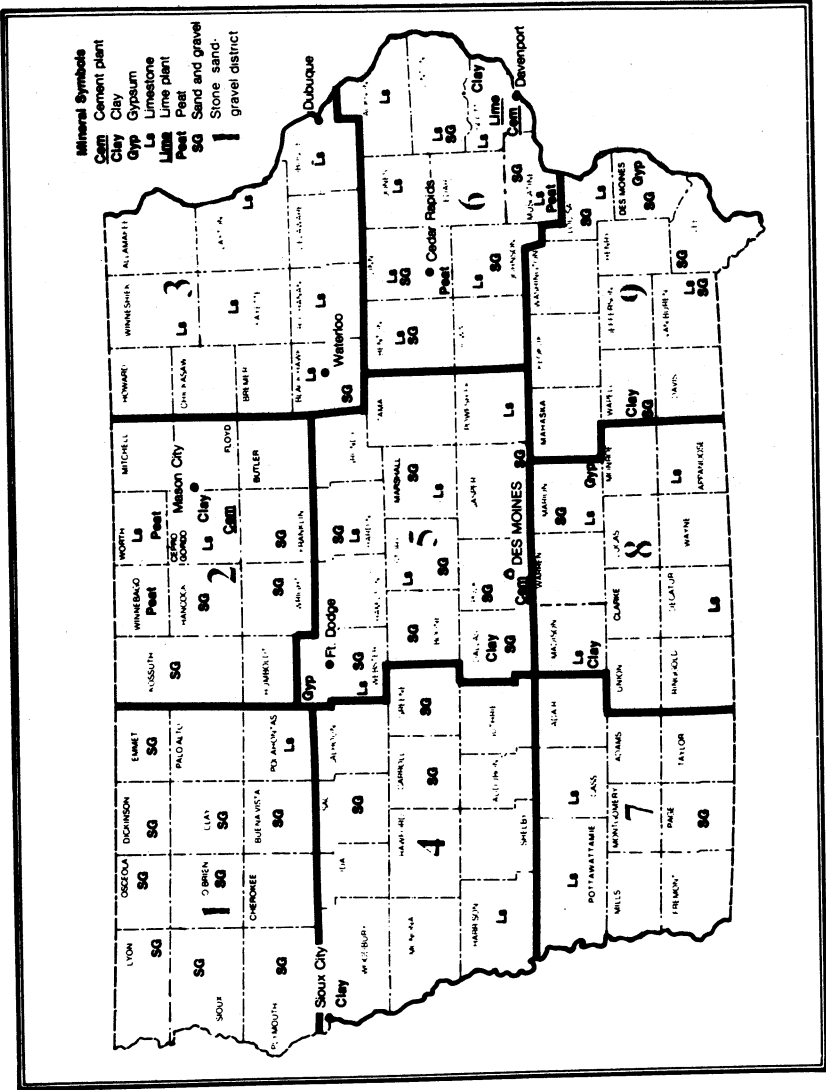


Figure 1.—Principal mineral-producing localities in Iowa.

**Legislation and Government Programs.**—In July 1986, the Iowa Geological Survey (IGS) was merged into the Iowa Department of Natural Resources. The IGS became a Bureau within the Energy and Geological Resources Division of the enlarged department. During the year, the IGS continued its participation in the Midcontinent Strategic and Critical Minerals Program (MSCMP), a U.S. Geological Survey-sponsored study of the geology and mineral resources of Iowa and portions of 11 other midcontinental States. The IGS also continued a comprehensive reevaluation of the State's stratigraphy, which benefited the MSCMP, ground water studies, the petroleum industry, and the Deep Observation and Sampling of the Earth's Continental Crust project.

The Mining and Mineral Resources Research Institute at Iowa State University in

Ames received a grant of \$142,000 from the U.S. Bureau of Mines for fiscal year 1986 under authorization of Public Law 98-409. In addition to basic and applied research, the institute also performed work on a limited basis for industry, with emphasis on mineral characterization, mineral processing, and mining engineering. During 1986, there were 17 research projects in progress. Examples of topics for some of these studies included rapid dissolution of coal and minerals for analysis, geochemical and petrological investigations of net-veined complexes in igneous intrusions, recovery of minerals from powerplant fly ash by high-temperature chlorination, development of measurement techniques to evaluate in situ stress in underground mine openings, and a geochemical investigation of minor Upper Mississippi Valley-type metal sulfide occurrences in Illinois, Iowa, and Wisconsin.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Falling interest rates contributed significantly to increased construction activity, which generally increased the demand for raw materials supplied by the minerals industry.

**Cement.**—In 1986, the cement industry in Iowa regained some of the losses in production and value it recorded in 1985. Production and value of portland cement were up about 12%. Masonry cement production increased 22% over that of 1985, but value declined about 5%.

Three companies produced portland cement, using a total of five kilns. Near Mason City, in Cerro Gordo County, Lehigh Portland Cement Co. and Northwestern States Portland Cement Co. operated dry-process plants. Davenport Cement Co. operated a dry-process plant near Buffalo, Scott County. Monarch Cement Co. ground clinker from its Humboldt, KS, facility at its plant in Des Moines, Polk County.

Principal markets for the cement products were ready-mixed concrete companies (65%), concrete product manufacturers (19%), building material dealers and other uses (11%), and highway contractors (5%).

**Clays.**—Clay production and value in 1986 were down compared with figures reported for 1985.

Midland Brick Co. installed equipment in

a new plant that will produce 8 to 9 million square feet of ceramic floor tile annually, at Redfield, Dallas County. Midland operated the only ceramic tile plant in Iowa. Clay for the tile was mined from a company-owned pit near the plant. Midland also operated brick plants in Redfield and Ottumwa.

**Gypsum.**—Crude gypsum production increased about 11% over that of 1985, and Iowa retained a national ranking of third; however, the total value decreased about 8%. Increased demand by the construction industry led to the production increase. The decrease in value was attributed to a decline in energy costs, which affected production costs. Lower production costs and intensive market competition resulted in lower sales prices to consumers.

**Lime.**—An increase over the levels recorded in 1985 was noted for Iowa's 1986 lime production and value. Linwood Mining and Minerals Corp. (formerly Linwood Stone Products Co. Inc.) was the State's sole producer. The Scott County operation produced mostly quicklime, with lesser quantities of hydrated lime.

**Peat.**—Production of peat in 1986 increased, while value declined from 1985 levels. Four companies reported production from Linn, Muscatine, Winnebago, and Worth Counties. Most of the peat was sold in bulk form, primarily for general soil improvement and golf courses.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Iowa's 1986 construction sand and gravel production was about 14.5 million short tons. Value increased about 33% over that estimated for 1985.

In 1986, the U.S. Bureau of Mines began

compiling construction sand and gravel statistics by districts for some States. Table 5 presents end-use data for construction sand and gravel produced in the nine Iowa districts depicted in figure 1.

In April, Martin Marietta Aggregates assumed ownership and operation of all construction sand and gravel and crushed stone quarries previously owned by Weaver Construction Co. of Alden. Weaver had been the State's largest producer of construction aggregates.

**Table 4.—Iowa: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	2,739	\$8,521	\$3.11
Plaster and gunite sands -----	62	251	4.05
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	98	381	3.89
Asphaltic concrete aggregates and other bituminous mixtures -----	621	1,933	3.11
Road base and coverings <sup>1</sup> -----	1,706	4,182	2.45
Fill -----	832	1,617	1.94
Snow and ice control -----	143	378	2.64
Railroad ballast -----	12	12	1.00
Other <sup>2</sup> -----	409	1,292	3.16
Other unspecified <sup>3</sup> -----	7,890	21,850	2.77
Total <sup>4</sup> or average -----	14,511	40,418	2.79

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes roofing granules.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Table 5.—Iowa: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4		District 5	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregates (including concrete sand) <sup>1</sup> -----	214	617	88	291	473	1,686	119	468	518	1,677
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	488	889	224	529	55	189	562	1,296	663	2,112
Fill -----	94	196	67	86	27	63	41	76	310	548
Snow and ice control -----	9	22	35	45	W	W	W	W	W	W
Railroad ballast -----	12	12	W	W	W	W	W	W	W	W
Roofing granules -----	W	W	W	W	W	W	W	W	W	W
Other -----	W	W	W	W	W	W	W	W	W	W
Other unspecified <sup>3</sup> -----	2,044	5,200	512	1,138	75	288	850	2,536	4,450	12,721
Total <sup>4</sup> -----	2,862	6,936	925	2,089	629	2,225	1,572	4,375	5,941	17,059

See footnotes at end of table.

**Table 5.—Iowa: Construction sand and gravel sold or used by producers in 1986, by use and district—Continued**

(Thousand short tons and thousand dollars)

Use	District 6		District 7		District 8		District 9	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coarse aggregates (including concrete sand) <sup>1</sup> -	915	2,481	W	W	W	W	314	932
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	221	686	W	W	W	W	37	120
Fill -----	160	416	W	W	W	W	104	166
Snow and ice control -----	60	184	---	---	W	---	2	W
Railroad ballast -----	---	---	---	---	---	---	---	---
Roofing granules -----	---	---	---	---	---	---	---	---
Other -----	105	234	---	---	W	W	W	W
Other unspecified <sup>3</sup> -----	143	696	259	988	124	462	139	368
<b>Total<sup>4</sup></b> -----	<b>1,603</b>	<b>4,697</b>	<b>259</b>	<b>988</b>	<b>124</b>	<b>462</b>	<b>596</b>	<b>1,586</b>

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).<sup>2</sup>Includes road and other stabilization (cement and lime).<sup>3</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Limestone was the only rock type used in crushed stone production. The estimated 1986 production and value remained at about the same levels as reported in 1985.

**Dimension.**—Estimated production and value of dimension stone in 1986 remained about the same as those reported for 1985.

## METALS

**Metallic ores** are not mined in Iowa; however, the State hosts processing facilities for aluminum, ferroalloys, iron and steel, molybdenum, and nickel. Metallic concentrates mined in other States and in foreign countries and metallic scrap from various industries are shipped to Iowa for processing.

**Aluminum.**—Aluminum Co. of America (Alcoa) announced it would establish its international headquarters for flat-rolled products in Davenport by transferring responsibility for manufacturing, sales, and marketing of products from its Pittsburgh, PA, offices. The firm also announced it would spend an estimated \$90 million over the next 3 years on a major modernization

of its Davenport Works. Plans called for the modernization of a 40-year-old rolling mill and ingot plant, new technology for a 72-inch rolling mill, and the installation of a computer-integrated manufacturing system throughout the facility.

On June 1, about 2,200 hourly workers from Alcoa's Davenport Works began a 5-week strike after the existing contract expired, and talks between the producer and the Aluminum, Brick, and Glass Workers Union were terminated. During the strike, the plant was operated by about 700 salaried employees; this action kept key customers supplied. The strike was part of a nationwide walkout against Alcoa that affected 15,000 hourly workers at 15 Alcoa plants in 9 States. A new 3-year contract, approved locally and nationally in early July, cut hourly benefits by 95 cents and froze wages. Givebacks included an extended vacation program, vacation bonuses, and certain cost-of-living increases. The new contract retained a cost-of-living adjustment if inflation reaches 3%, plus vision, dental, and health care insurance.

The new agreement fell short of goals sought by both sides. The union requested profit sharing as a means to recover any givebacks. A labor-management committee was to study the issue as part of the agreement. Alcoa, like other domestic aluminum producers, was beset with an oversupply of primary aluminum, sluggish

prices, and high costs for energy and labor and had initially proposed a \$2.90-per-hour wage and benefit cut. The union countered with a demand for a 3%, or 40-cent-per-hour, increase in the average hourly wage of \$13.

**Iron and Steel.**—Deere & Co. closed its Dubuque gray-iron foundry early in the year; this action increased production at its Waterloo foundry.

Footo Mineral Co. of Exton, PA, was placed on sale in July. The firm, of which Newmont Mining Corp. was the majority owner, operated a ferroalloy plant in Keokuk that produced 50% ferrosilicon and silvery pig iron.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Geologist, Iowa Geological Survey Bureau, Iowa City, IA.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Davenport Cement Co., a subsidiary of Cementia Holdings AG.	220 Emerson Pl. Suite 300 Davenport, IA 52801	Quarry, clay pit, plant.	Scott.
Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG.	Box 1882 Allentown, PA 18105	-----do-----	Cerro Gordo.
Monarch Cement Co -----	Humboldt, KS 66748 ---	Plant-----	Polk.
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Quarry and clay pit -- Quarry and plant ---	Madison. Cerro Gordo.
<b>Clays:</b>			
Midland Brick Co -----	Box A Redfield, IA 50233	Pit and plant -----	Wapello.
Sioux City Brick & Tile Co ---	501 Orpheum Bldg. Box 87 Sioux City, IA 51102	Pits and plants -----	Dallas and Woodbury.
<b>Gypsum:</b>			
Celotex Div., a subsidiary of Jim Walter Corp.	1500 North Dale Mabry Tampa, FL 33607	Open pit mine and plant.	Webster.
Georgia-Pacific Corp -----	133 Peachtree St., NE. Atlanta, GA 30303	-----do-----	Do.
Kaser Corp -----	Box 3569 Des Moines, IA 50322	Underground mine and plant.	Marion.
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant.	Webster.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plant. Open pit mine and plant.	Des Moines. Webster.
<b>Lime:</b>			
Linwood Mining and Minerals Corp.	Route 2 Davenport, IA 52804	Plant-----	Scott.
<b>Peat:</b>			
Eli Colby Co -----	Box 248 Lake Mills, IA 50450	Bog and plant-----	Winnebago.
Colby Pioneer Peat Co -----	Box 8 Hanlontown, IA 50444	-----do-----	Worth.
Hughes Peat Co -----	Route 2 Marion, IA 52302	-----do-----	Linn.
Pikes Peat Co -----	Route 6, Box 21 Muscatine, IA 52761	-----do-----	Muscatine.
<b>Perlite (expanded):</b>			
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	Plant-----	Webster.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	-----do-----	Do.
<b>Sand and gravel (construction):</b>			
Acme Fuel & Material Co ---	Route 5, Box 34 Muscatine, IA 52761	Pit and plant -----	Muscatine.
G. A. Finley Inc -----	Box 406 Harlan, IA 51537	Pits and plants -----	Cass, Dallas, Montgomery, Page, Pottawattamie, Shelby, Audubon, Boone, Cherokee, Dallas, Franklin, Marshall, Osceola, Polk, Sac, Story, Various (20 counties).
Hallett Construction Co ---	Box 13 Boone, IA 50036	-----do-----	
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	-----do-----	
Stevens Sand & Gravel Co. Inc	Route 4, Box 35 Iowa City, IA 52240	-----do-----	Johnson and Washington.
Van Dusseldorp Sand & Gravel Inc.	Box 156 Colfax, IA 50054	-----do-----	Jasper and Marion.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone (limestone, 1985):			
Crushed:			
B. L. Anderson Inc. -----	123 Third Ave., SW, Cedar Rapids, IA 52406	Quarries and plants --	Benton, Clinton, Jackson, Johnson, Jones, Linn, Tama.
Kaser Corp -----	7200 Hickman Rd. Des Moines, IA 50322	Underground mines, quarries, plants.	Des Moines, Jasper, Keokuk, Marion, Monroe, Polk, Poweshiek, Washington.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	-----do-----	Clarke, Decatur, Linn, Madison, Marshall, Polk, Story.
P. Niemann Construction Co.	106 North Maple St. Sumner, IA 50674	Quarries and plants --	Black Hawk, Bremer, Buchanan, Butler, Chickasaw, Fayette, Winneshiek.
River Products Co -----	220 Savings & Loan Bldg. Iowa City, IA 52240	Underground mine, quarries, plants.	Johnson, Louisa, Washington.
Schildberg Construction Co. Inc.	Box 358 Greenfield, IA 50849	Quarries and plants --	Adair, Adams, Cass, Madison, Pottawattamie, Union.
Dimension:			
Wm. Becker & Sons Stone Co.	1735 Kaufmann Ave. Dubuque, IA 52001	Quarry and plant ---	Dubuque.
Weber Stone Co. <sup>1</sup> -----	Route 1 Anamosa, IA 52205	-----do-----	Jones.

<sup>1</sup>Also crushed limestone.





# The Mineral Industry of Kansas

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

By Jane P. Ohl<sup>1</sup> and David A. Grisafe<sup>2</sup>

Nonfuel mineral production in Kansas was valued at \$317.6 million, an insignificant decrease from that of 1985. Nationally, the State ranked 24th in value of nonfuel mineral production, and cement and salt continued to account for the greatest portion of the State's nonfuel mineral value.

Although total value of minerals pro-

duced in the State in 1986 remained relatively unchanged, increases in output were reported for construction sand and gravel, crude gypsum, masonry cement, and crushed stone. Pumice output increased more than 88%; its increased use in research and development accounted for most of the rise in output.

Table 1.—Nonfuel mineral production in Kansas<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry						
thousand short tons	W	W	W	W	51	\$3,264
Portland	W	W	W	W	1,763	91,110
Clays	918	\$5,537	878	\$5,326	903	5,295
Gem stones	NA	<sup>e</sup> 1	NA	<sup>e</sup> 1	NA	3
Helium:						
Crude	402	8,844	W	W	W	W
Grade-A	1,015	38,063	W	W	W	W
Salt <sup>2</sup>	1,712	71,558	1,790	71,970	1,656	68,887
Sand and gravel:						
Construction	11,796	26,358	<sup>e</sup> 13,200	<sup>e</sup> 31,800	15,609	33,721
Industrial	W	W	134	1,124	132	1,155
Stone (crushed)	<sup>e</sup> 13,600	<sup>e</sup> 48,500	15,653	57,155	<sup>e</sup> 16,600	<sup>e</sup> 60,300
Combined value of gypsum, lime (1984), pumice, salt (brine), stone (dimension), and values indicated by symbol W	XX	<sup>f</sup> 113,774	XX	<sup>f</sup> 154,793	XX	53,910
Total	XX	<sup>f</sup> 312,635	XX	<sup>f</sup> 322,169	XX	317,645

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes salts in brines; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Kansas in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Allen	Cement, stone (crushed), clays.
Anderson	Stone (crushed).
Atchison	Do.
Barber	Gypsum.
Barton	Clays.
Bourbon	Stone (crushed).
Brown	Do.
Butler	Do.
Chase	Stone (dimension).
Chautauqua	Stone (crushed).
Cherokee	Clays, stone (crushed).
Clay	Stone (crushed).
Cloud	Clays.
Coffey	Stone (crushed).
Cowley	Stone (crushed), stone (dimension).
Crawford	Stone (crushed), clays.
Dickinson	Stone (crushed).
Doniphan	Do.
Douglas	Do.
Elk	Do.
Ellis	Do.
Ellsworth	Salt, clays.
Franklin	Stone (crushed), clays.
Geary	Stone (crushed).
Greenwood	Do.
Jefferson	Do.
Jewell	Stone (crushed), clays.
Johnson	Stone (crushed).
Labette	Do.
Leavenworth	Do.
Lincoln	Do.
Linn	Do.
Lyon	Do.
McPherson	Clays.
Marion	Stone (crushed).
Marshall	Gypsum, stone (crushed).
Miami	Stone (crushed).
Montgomery	Cement, stone (crushed), clays.
Neosho	Do.
Neos	Stone (crushed).
Norton	Pumice, stone (crushed).
Osage	Stone (crushed).
Pottawatomie	Stone (crushed), stone (dimension).
Reno	Salt.
Republic	Sand (industrial).
Rice	Salt, stone (crushed).
Riley	Stone (crushed), stone (dimension).
Sedgwick	Salt.
Shawnee	Stone (crushed).
Smith	Do.
Wilson	Cement, stone (crushed), clays.
Woodson	Clays.
Wyandotte	Cement, stone (crushed), sand (industrial).
Undistributed <sup>2</sup>	Sand and gravel (construction), helium, gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Kansas business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	2,442	2,449	2,460
Total civilian labor force -----	do.	1,197	1,235	1,224
Unemployment -----	percent	5.0	5.0	5.4
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	17.9	16.7	12.3
Nonmetallic minerals except fuels <sup>1</sup> -----	do.	1.3	1.2	1.2
Coal mining <sup>1</sup> -----	do.	.4	.4	.3
Oil and gas extraction -----	do.	16.3	15.1	10.8
Manufacturing total -----	do.	176.4	174.4	175.4
Primary metal industries -----	do.	3.2	3.0	3.0
Stone, clay, and glass products -----	do.	6.9	6.8	7.0
Chemicals and allied products -----	do.	8.0	8.0	8.0
Petroleum and coal products -----	do.	3.1	3.0	3.0
Construction -----	do.	43.6	42.3	43.7
Transportation and public utilities -----	do.	64.1	63.9	62.3
Wholesale and retail trade -----	do.	239.4	243.3	246.7
Finance, insurance, real estate -----	do.	51.3	52.8	54.2
Services -----	do.	182.8	185.8	193.2
Government and government enterprises -----	do.	185.2	188.7	195.0
Total <sup>2</sup> -----	do.	960.8	967.9	982.7
<b>Personal income:</b>				
Total -----	millions	\$32,076	\$34,063	\$26,042
Per capita -----		\$13,137	\$13,907	\$14,650
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		40.1	39.5	40.3
Mining -----		44.6	43.9	39.7
Total average hourly earnings, production workers -----		\$9.4	\$9.5	\$9.7
Mining -----		\$9.4	\$9.8	\$10.0
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$917	\$1,217	\$1,517
Nonfarm -----	do.	\$21,265	\$22,334	\$23,523
Mining total -----	do.	\$528	\$525	\$389
Nonmetallic minerals except fuels -----	do.	\$26	\$27	\$23
Coal mining -----	do.	\$16	\$16	\$13
Oil and gas extraction -----	do.	\$486	\$482	\$353
Manufacturing total -----	do.	\$4,464	\$4,594	\$4,866
Primary metal industries -----	do.	\$81	\$75	\$78
Stone, clay, and glass products -----	do.	\$189	\$191	\$193
Chemicals and allied products -----	do.	\$228	\$243	\$266
Petroleum and coal products -----	do.	\$121	\$119	\$124
Construction -----	do.	\$1,414	\$1,422	\$1,560
Transportation and public utilities -----	do.	\$1,061	\$2,072	\$2,114
Wholesale and retail trade -----	do.	\$3,748	\$3,958	\$4,108
Finance, insurance, real estate -----	do.	\$1,147	\$1,239	\$1,385
Services -----	do.	\$4,115	\$4,454	\$4,768
Government and government enterprises -----	do.	\$3,697	\$3,973	\$4,226
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		16,727	13,267	\$13,086
Value of nonresidential construction <sup>4</sup> -----	millions	\$549.5	\$539.8	\$655.8
Value of State road contract awards <sup>5</sup> -----	do.	\$277.5	\$275.7	\$256.8
Shipments of portland and masonry cement to and within the State -----	thousand short tons	1,266	1,313	1,239
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$312.6	\$322.2	\$317.6
Value per capita -----		\$128	\$131	\$129

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Kansas Department of Human Resources, Division of Employment.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

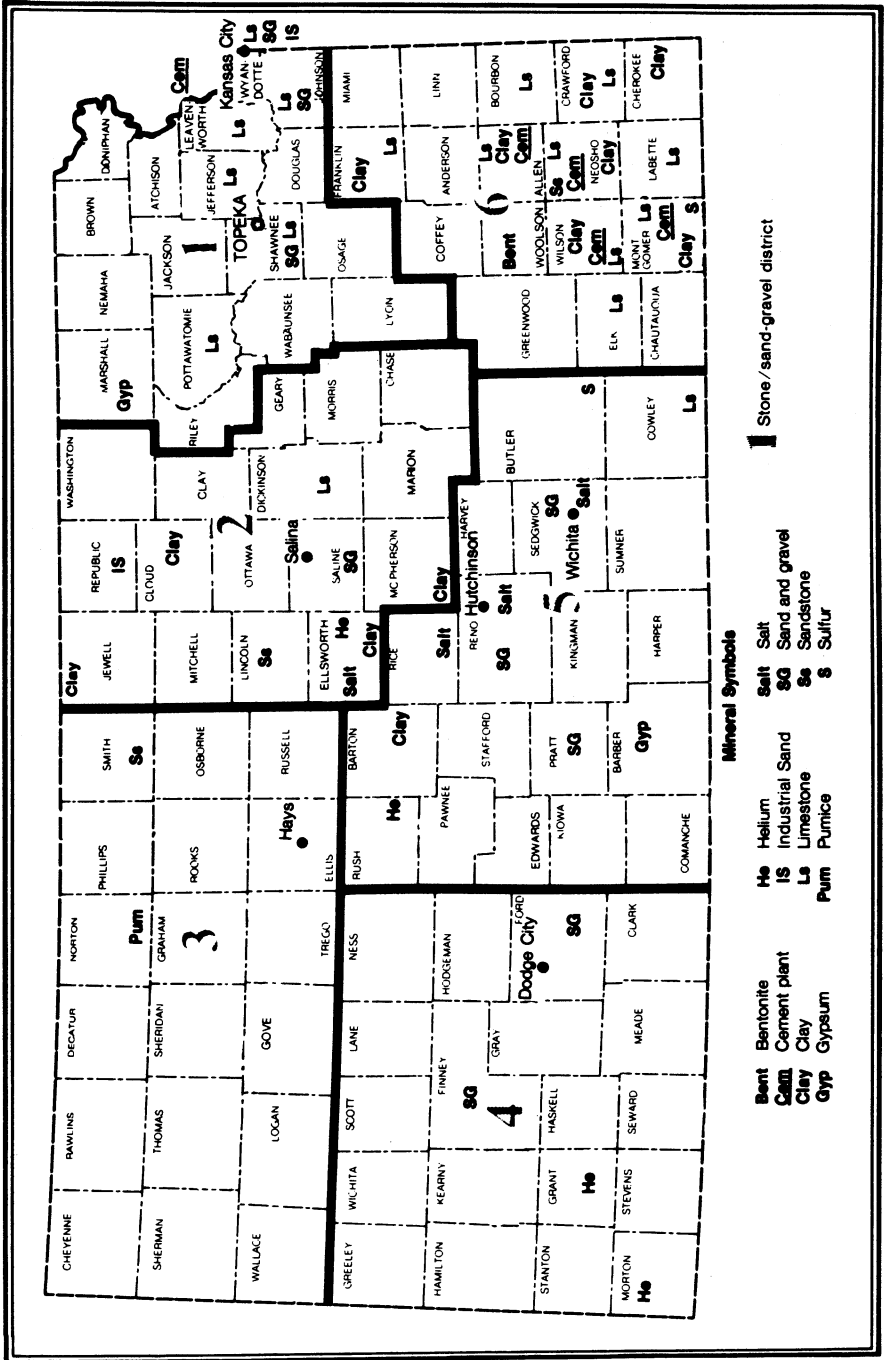


Figure 1.—Principal mineral-producing localities in Kansas.

**Trends and Developments.**—Mineral output and values were mixed during the 1984-86 period. Quantity and value of construction sand and gravel and crushed stone trended upward, but the unit price remained static for crushed stone and decreased slightly for construction sand and gravel.

Crude helium and industrial sand output were on a downward 3-year trend, as was the total value of crude helium. No distinct trends were discerned for quantities and values of Grade-A helium, masonry and portland cement, or salt. Unit prices, however, for masonry cement rose while those for portland cement fell during 1984-86.

These 3-year trends were related to the overall Kansas economy, which continued to be depressed by adverse conditions in the oil and gas and agricultural industries, major components of the State's economy. It was estimated that one-third of the State's petroleum geologists no longer had jobs and that farmers were using only about one-fourth of former agricultural lime requirements, as indicated by soil tests recorded by the Kansas Department of Agriculture.

The ripple effect of the depressed oil and gas and agricultural industries was extensive: Fewer incoming tax revenue dollars translated into lower construction levels in Kansas than in many other States. Figures for fiscal year 1987 (ending June 30), supplied by the Kansas Department of Transportation, showed that 352 contracts were let during the fiscal year at a value of \$251 million. The majority of the contracts involving the construction of interstate highways I-670 and I-435 in the Kansas City area were completed during fiscal year 1987.

Despite a sales tax increase, income to the State was less, and the rate of business failures and unemployment generally outstripped the 1985 pace; but employment in the nonfuel minerals sector increased over that reported for 1985.

**Employment.**—According to the Kansas Department of Human Resources, Division of Employment, the average monthly employment in mining and quarrying, excluding mineral fuels, was about 1,500 persons, compared with the 1,214 persons reported in 1985.

**Environment.**—At yearend 1986, American Salt Co., a subsidiary of General Host Corp., awaited a judgment against it for

damages to approximately 2,800 acres near Lyons, Rice County, during the 9-year period 1975-83. Beginning in July 1984, American Salt and its wholly owned subsidiary, Cudahy Co. (now AMS Industries Inc.), had voluntarily implemented a ground water cleanup program and expected to reach an agreement early in 1987 with the Kansas Department of Health and Environment about a future remedial program.<sup>3</sup> A U.S. District Court judge ordered American Salt to pay \$3 million in actual damages to area farmers.

Several salt mines near Lyons were being considered by the Central Interstate Low-Level Radioactive Waste Compact Commission as sites for low-level radioactive waste dumps.

Environmental problems in Cherokee County at the long-inactive Tri-State lead-zinc mining district continued unresolved. The Governor of Kansas proposed filling the collapsed and widening shafts with piles of crushed rock and requested a study of any possible environmental impact if abandoned mine shafts in the area were to be filled. An earlier U.S. Bureau of Mines study<sup>4</sup> identified more than 370 abandoned shafts in and around Galena that were spaced as closely as two or three per acre and were as deep as 450 feet. The Cherokee County Task Force was to act as liaison between local, county, State, and Federal agencies and the public in solving problems.

**Legislation and Government Programs.**—No legislation specifically related to the mining industry was enacted in 1986, although two bills dealing with the State's natural resources were enacted: House bill 3077, regulation of oil and gas activities by corporation commission to prevent water pollution, was signed by the Governor on May 8, and Senate bill 0678, regulation of oil well and gas well drilling, was signed on May 6.

Some owners of private land had turned over their surface rights to the U.S. Forest Service in 1936 but retained rights to explore and develop the mineral estate for 50 years. These estates began reverting to Federal ownership during 1986. Of specific interest were rights in the Cimarron National Grasslands in Morton County, southwestern Kansas, underlain in part by the Hugoton Gasfield.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Production and value of both masonry and portland cement improved over figures for 1985. Whereas the average price for masonry cement rose from \$63.17 per short ton in 1985 to \$63.89 in 1986, the price of portland cement fell \$1.64 to \$51.68.

The five plants operating in 1986 produced more than 1.7 million short tons of portland cement and 51,091 tons of masonry cement. The firms operated eight wet-process and seven dry-process kilns.

Raw materials consumed were 1.4 million tons of limestone, 1.3 million tons of cement rock, 0.268 million tons of shale, and smaller amounts of clays, gypsum, iron ore, mill scale, pyrite, industrial sand, sandstone, and various resins and chemicals.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (74.7% of shipments), contractors, highway contractors, concrete product manufacturers, building material dealers, miscellaneous customers, and government agencies.

Bulk shipments of portland cement from plants to terminals were transported by truck (accounting for 52.5% of shipments) and by rail.

Fuels used to produce cement were predominantly natural gas, with some soft and hard coals, and a very small amount of fuel oil. Systech Corp., Xenia, OH, supplied organic waste solvents (waste-derived fuel) to the General Portland Inc. cement plant at Fredonia, Wilson County. Systech tested the waste solvents to ensure that harmful materials, such as pesticides, were not present. General Portland used substantial amounts of the waste-derived fuel at Fredonia and, in so doing, eliminated a waste disposal problem and lowered production costs.

Heartland Cement Co., St. Louis, MO, purchased Lehigh Portland Cement Co.'s plant at Independence, KS. Heartland, owned by Rugby Portland Cement of the United Kingdom and Unicem of Italy, was the smallest of the State's five portland cement producers.

**Table 4.—Kansas: Masonry cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	5	5
Production	W	49,617
Shipments from mills:		
Quantity	W	51,091
Value	W	\$3,264,261
Stocks at mills, Dec. 31	W	20,257

W Withheld to avoid disclosing company proprietary data.

**Table 5.—Kansas: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	5	5
Production	W	1,746,520
Shipments from mills:		
Quantity	W	1,762,802
Value	W	\$91,110,212
Stocks at mills, Dec. 31	W	225,892

W Withheld to avoid disclosing company proprietary data.

**Clays.**—Nationally, Kansas ranked 20th in total clay and shale production. Output increased slightly, while total value and average unit price fell insignificantly.

Common clay and shale was produced by 11 companies at 19 pits in 13 counties. About 42% of clay output was used in the manufacture of cement. Clay from Jewell County supplied Ideal Basic Industries Inc.'s cement plant at Superior, NE.

The second largest use of clay was for lightweight aggregate, followed by face brick manufacture (26.1%). Lesser quantities of clay were used in the manufacture of sewer pipe and roofing tile. The major use of the lightweight aggregate was for concrete.

Output and value of calcium (low-swelling) bentonite, the only other type of clay reported from Kansas mines, increased over 1985 output and value. Price per short ton was nearly unchanged at \$37.28. Bentonitic clay mined in Woodson County was used for manufacturing feed and fertilizer supplements.

**Gypsum.**—Nationally, Kansas ranked eighth in production of crude gypsum. Output increased 11% during 1986. Average price per short ton of crude gypsum remained about the same as the 1985 price. Calcined gypsum output increased, but value fell in 1986. Sales were influenced by increased residential starts and use of gypsum board in construction.

Two companies produced crude and calcined gypsum in the State. Georgia-Pacific Corp. operated an underground mine and calcining plant at Blue Rapids, Marshall County, and National Gypsum Co. operated an underground and surface mine at Sun City, Barber County, and calcined the crude gypsum at its Medicine Lodge plant. Sun City Mine was the 7th largest gypsum mine, and Medicine Lodge plant, the 10th largest calcining plant in the Nation.

**Helium.**—Kansas continued to be the Nation's leading producer of crude and Grade-A helium and the second-ranking of 11 States that have proven natural gas reserves containing 0.3% or more helium. U.S. Bureau of Mines Information Circular 9130, "Helium Resources of the United States, 1985," includes data about Kansas.

**Perlite (Expanded).**—Crude perlite shipped in from other States was expanded at the Lite-Weight Products Inc. plant in Kansas City. Output increased about 38% in 1986.

**Pumice and Pumicite.**—Calvert Corp. was the State's sole producer of pumice. Production was from a small mine and plant in Norton County. Output increased about 88% in 1986 through the owner's continuing efforts to tap new markets, especially research and development.

**Salt.**—Half the State's salt output was from evaporated brines. Price per short ton returned to nearly the 1984 level of over \$41.

American Salt continued to operate a plant southeast of Lyons (Rice County) and to work on cleaning up the aquifer and farm fields polluted by brine spills. (See "Environment.") Carey Salt Co., a division of Processed Minerals Inc., employed about 240 persons, most of them at its evaporating plant; only 16 worked in Carey's mine at Hutchinson, Reno County. Independent Salt Co. continued rock salt mining oper-

ations at Kanopolis, Ellsworth County. Morton Salt Co. (a division of Morton Thiokol Inc.) and Cargill Inc. also operated evaporating plants in Hutchinson, but mined no rock salt. Morton reduced its workweek and laid off several employees in early 1986. The largest producer among these five in 1986 was American Salt.

Depending on use, price of salt ranged from \$1.52 to \$91.20 per ton and averaged \$41.60.

The town of Hutchinson proposed building a salt museum in Reno County. The town already has underground storage for films and records in a mined-out part of the Carey salt mine.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Nationally, Kansas ranked 18th in the production of sand and gravel for construction purposes. Output increased more than 18% compared with 1985 output, and total value increased about 6%. Construction sand and gravel was produced by 113 companies and government agencies at 322 pits in 61 of the State's 105 counties. Sedgwick County led the State's production. Three of 144 operations were in the 800,000- to 1,500,000-short-ton-per-year range; 38 operations produced less than 25,000 tons each.

Major uses of construction sand and gravel were for concrete aggregates, road base and coverings, asphaltic concrete aggregates and other bituminous mixtures, fill, plaster and gunite sands, snow and ice control, and concrete products such as blocks, bricks, pipe, and decorative items. Average price of all uses was \$2.16 per ton, down somewhat from that reported for 1984, and nearly one-third less than the national average price in 1986.

Ritchie Sand Co., Sedgwick County, completed its first production year at a new \$1.5 million facility, the largest in Kansas. Situated in the floodplain of the Arkansas River, the company operated for 10 months at an average 50 to 60 hours per week. The plant had an annual capacity of about 750,000 to 1 million tons of product.



**Table 6.—Kansas: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	3,340	\$7,433	\$2.23
Plaster and gunite sands -----	788	1,870	2.37
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	29	91	3.14
Asphaltic concrete aggregates and other bituminous mixtures -----	1,764	4,076	2.31
Road base and coverings <sup>1</sup> -----	2,910	5,290	1.82
Fill -----	1,581	2,305	1.46
Snow and ice control -----	120	361	3.01
Other <sup>2</sup> -----	140	464	3.31
Other unspecified <sup>3</sup> -----	4,937	11,832	2.40
<b>Total or average -----</b>	<b>15,609</b>	<b>*\$3,721</b>	<b>2.16</b>

<sup>1</sup>Includes road and other stabilization (cement).<sup>2</sup>Includes roofing granules.<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>4</sup>Data do not add to total shown because of independent rounding.**Table 7.—Kansas: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	1,716	3,845	225	690	W	W
Asphaltic concrete aggregates and other bituminous mixtures -----	902	1,970	117	351	110	209
Road base and coverings <sup>2</sup> -----	213	508	118	336	607	733
Fill -----	395	535	105	144	186	212
Snow and ice control -----	22	81	4	10	( <sup>3</sup> )	( <sup>3</sup> )
Roofing granules -----	W	W	--	--	--	--
Other -----	36	195	9	10	18	32
Other unspecified <sup>4</sup> -----	2,793	7,218	428	722	219	380
<b>Total<sup>5</sup> -----</b>	<b>6,078</b>	<b>14,352</b>	<b>1,007</b>	<b>2,263</b>	<b>1,140</b>	<b>1,616</b>
Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	W	W	2,060	4,380	--	--
Asphaltic concrete aggregates and other bituminous mixtures -----	102	326	532	1,221	--	--
Road base and coverings <sup>2</sup> -----	977	1,559	899	1,830	96	275
Fill -----	38	72	858	1,341	--	--
Snow and ice control -----	17	75	76	195	--	--
Roofing granules -----	--	--	W	W	--	--
Other -----	172	484	60	221	--	--
Other unspecified <sup>4</sup> -----	317	1,277	976	1,789	204	446
<b>Total<sup>5</sup> -----</b>	<b>1,623</b>	<b>3,793</b>	<b>5,462</b>	<b>10,978</b>	<b>300</b>	<b>720</b>

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).<sup>2</sup>Includes road and other stabilization (cement).<sup>3</sup>Less than 1/2 unit.<sup>4</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>5</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Industrial sand was produced in Republic and Wyandotte Counties by three companies. Wyandotte County, with two operations, led the State's production. Production decreased, but total value increased slightly. Uses of industrial sand included fiberglass (according to the Kansas Geological Survey) and sandblasting. All transported industrial sand was moved by truck.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone production and value were estimated to have increased 6% in 1986. Historically, Kansas' crushed stone has been used for agricultural limestone,

cement and lime manufacture, concrete and bituminous aggregates, filler stone, railroad ballast, and miscellaneous uses. Lime manufacture, however, has not occurred since 1984, when the State's sole producer declared bankruptcy.

The Kansas Limestone Association ceased to exist in 1986 as a separate entity and merged with the Kansas Aggregate Producers Association-Kansas Ready-Mixed Concrete Association, a coalition thought to lead to greater economy and efficiency for all three groups.

Koppers Co. and British-based Redland PLC formed a joint venture, Western-Mobile Inc., to produce and supply construction materials in Kansas and three other Western States.

*Dimension.*—Production and value of di-

mension stone were estimated to have decreased substantially from figures reported in 1985.

**Sulfur (Recovered).**—Sulfur was recovered at the petroleum refining operations of Texaco Refining & Marketing Co. at El Dorado in Butler County and of Farmland Industries Inc. at Coffeyville in Montgomery County. Sales dropped 21% in 1986, following a drop of 18% in 1985. Unit value increased \$0.56 per metric ton.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.

<sup>2</sup>Associate scientist, Mineral Information, Kansas Geological Survey, Lawrence, KS.

<sup>3</sup>General Host Corp. 1986 Annual Report to the S.E.C. P. 340.

<sup>4</sup>Kansas Geological Survey. A Study of Stability Problems and Hazard Evaluation of the Kansas Portion of the Tri-State Mining Area. (Contract J0100131). BuMines CFR 75-83, 1983, 193 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Ash Grove Cement Co. <sup>1 2</sup> -----	Box 25900 Overland Park, KS 66225	Plant and quarry ---	Neosho.
General Portland Inc., Victor Div., LaFarge Corp. <sup>3</sup> -----	7701 East Kellogg St. Suite 240 Wichita, KS 67207	----do -----	Wilson.
Lehigh Portland Cement Co., Heidelberg Zement AG. <sup>4</sup> -----	718 Hamilton Mall Allentown, PA 18105	----do -----	Montgomery.
Lone Star Industries Inc. <sup>5</sup> -----	Box 12449 Dallas, TX 75225	----do -----	Wyandotte.
The Monarch Cement Co. <sup>6</sup> -----	Box 187 Humboldt, KS 66748	----do -----	Allen.
<b>Clays:</b>			
Buildex Inc., a division of Clemens Coal Co. -----	Box 299 Pittsburg, KS 66762	Pits and plants -----	Franklin and McPherson.
Cloud Ceramics, a division of General Finance Inc. -----	Box 989 Concordia, KS 66901	Pits and plant -----	Cloud.
W. S. Dickey Clay Manufacturing Co. -----	Box 8789 Pittsburg, KS 66762	----do -----	Cherokee and Crawford.
Ideal Basic Industries Inc. -----	Box 8789 Denver, CO 80201	Pit -----	Jewell.
Justin Industries Inc., Acme Brick Co. -----	Box 98 Kanopolis, KS 67454	Pits and plants -----	Cherokee and Ellsworth.
Kansas Brick & Tile Co. Inc. -----	Box 540 Hoisington, KS 67544	Pit and plant -----	Barton.
Micro-Lite Inc. -----	Route 4, Box 50B Chanute, KS 66720	----do -----	Woodson.
<b>Gypsum:</b>			
Georgia-Pacific Corp. -----	133 Peachtree St., NE. Atlanta, GA 30303	Underground mine and plant.	Marshall.
National Gypsum Co. -----	2001 Rexford Rd. Charlotte, NC 28211	Open pit, underground mine, plant.	Barber.
<b>Helium:</b>			
Kansas Refined Helium Co. -----	Otis, KS 67565 -----	Plant -----	Rush.
Union Carbide Corp., Linde Div. -----	Box 444 Somerset, NJ 08873	Plants -----	Ellsworth, Grant, Morton, Rush.
<b>Perlite (expanded):</b>			
Lite-Weight Products Inc. -----	1706 Kansas Ave. Kansas City, KS 66105	Plant -----	Wyandotte.
<b>Pumice and pumicite:</b>			
Calvert Corp. -----	Box 97 Norton, KS 67654	Pit and plant -----	Norton.
<b>Salt:</b>			
American Salt Co. -----	3142 Broadway Kansas City, MO 64111	Wells and underground mine.	Rice.
Carey Salt Co., a division of Processed Minerals Inc. -----	1800 Carey Blvd. Hutchinson, KS 67501	Underground mine --	Reno.
Cargill Inc., Salt Div. -----	Box 1403 Hutchinson, KS 67501	Wells -----	Do.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Salt —Continued</b>			
Independent Salt Co -----	Box 36 Kanopolis, KS 67454	Underground mine --	Ellsworth.
Morton Salt Co., a division of Morton Thiokol Inc.	110 North Wacker Dr. Chicago, IL 60606	Wells -----	Reno.
Vulcan Materials Co., Chemical Div --	Box 7689 Birmingham, AL 35223	-----do -----	Sedgwick.
<b>Sand and gravel (construction):</b>			
Associated Material & Supply Co. Inc -	Box 4064 Wichita, KS 67204	Pit and plant -----	Sedgwick and Sumner.
Builders Sand Co -----	4150 Kansas Ave. Kansas City, KS 66106	Dredges and plants --	Johnson, Shawnee, Wyandotte.
Holliday Sand & Gravel Co., a division of List & Clark Construction Co. <sup>7</sup>	6811 West 63d St. Overland Park, KS 66202	Pits and plants -----	Johnson and Wyandotte.
Ritchie Sand Co., a division of Ritchie Corp.	Box 8901 Wichita, KS 67204	Dredge and plant ---	Sedgwick.
<b>Stone:</b>			
<b>Crushed:</b>			
N. R. Hamm Quarry Inc -----	Box 17 Perry, KS 66073	Quarries and plants --	Various (7 counties).
Inland Quarries -----	Box 2249 7000 Holliday Dr. Kansas City, KS 66106	Underground mine and plant.	Wyandotte.
McAdam Construction Co -----	Main St. Moran, KS 66755	Quarries and plants --	Allen, Anderson Bourbon, Cowley, Linn.
Martin Marietta Aggregates, Central Div.	Box 30013 Raleigh, NC 27622	-----do -----	Various (7 counties).
Midwest Minerals Inc -----	Box 412 709 North Locust Pittsburg, KS 66762	-----do -----	Cherokee, Crawford, Labette, Montgom- ery, Neosho, Wilson.
<b>Dimension:</b>			
Bayer Stone Inc -----	120 North Sixth St. St. Marys, KS 66536	Quarries -----	Pottawatomie and Riley.
H. J. Born Stone Co. Inc -----	Route 3, Box 312 Arkansas City, KS 67005	-----do -----	Chase and Cowley.
<b>Sulfur (recovered):</b>			
Farmland Industries Inc -----	North Linden St. Coffeyville, KS 67337	Secondary recovery plant.	Montgomery.
Texaco Refining & Marketing Co ----	Box 1650 Tulsa, OK 74102	-----do -----	Butler.

<sup>1</sup>Also clays in Neosho County.<sup>2</sup>Also crushed stone in Johnson, Linn, and Neosho Counties.<sup>3</sup>Also clays and crushed stone in Wilson County.<sup>4</sup>Also clays and crushed stone in Montgomery County.<sup>5</sup>Also crushed stone in Wyandotte County.<sup>6</sup>Also clays and crushed stone in Allen County.<sup>7</sup>Also industrial sand in Wyandotte County.

# The Mineral Industry of Kentucky

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

By L. J. Prosser, Jr.<sup>1</sup>

The value of nonfuel mineral production in Kentucky in 1986 was \$267 million, about the same as that of 1985. Output of nonfuel mineral commodities has remained about the same for the last 3 years.

Kentucky has been the Nation's leading coal-producing State since the early 1970's, annually accounting for more than 20% of the U.S. total. The coal industry, because of its size and value, was a significant compo-

nent of the State's economy and provided a market for nonfuel minerals. Construction aggregate for highways and lime and limestone used as rock dust and in acid mine drainage neutralization were essential in the transportation and production of coal. In addition, developments in clean coal technology have boosted the potential for increased demand for limestone, the State's leading nonfuel commodity.

Table 1.—Nonfuel mineral production in Kentucky<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ----- thousand short tons--	662	\$2,533	775	\$6,487	721	\$3,450
Gem stones-----	NA	*1	NA	*1	NA	3
Sand and gravel (construction) thousand short tons--	7,839	18,252	*7,600	*19,000	7,194	16,986
Stone (crushed) <sup>3</sup> ----- do-----	*37,300	*133,000	38,022	134,978	*38,400	*137,000
Combined value of cement, clays (ball clay and fire clay, 1984, 1986), lime, sand and gravel (industrial), stone (crushed sandstone, 1985-86), and zinc (1984-85)-----	XX	103,422	XX	107,092	XX	109,826
Total-----	XX	257,208	XX	267,558	XX	267,265

<sup>1</sup>Estimated. NA Not available. XX Not applicable.

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

<sup>3</sup>Excludes ball clay and fire clay; value included with "Combined value" figure.

<sup>4</sup>Excludes crushed sandstone; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Kentucky in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adair	Stone (crushed).
Allen	Do.
Anderson	Do.
Barren	Do.
Boone	Do.
Bourbon	Do.
Boyd	Clays.
Boyle	Stone (crushed).
Breckinridge	Do.
Bullitt	Stone (crushed), clays.
Caldwell	Stone (crushed).
Calloway	Sand (industrial).
Carlisle	Clays.
Carter	Stone (crushed), clays.
Casey	Stone (crushed).
Christian	Do.
Clinton	Do.
Crittenden	Do.
Cumberland	Do.
Edmonson	Do.
Estill	Do.
Fayette	Do.
Fleming	Do.
Floyd	Do.
Franklin	Do.
Garrard	Do.
Graves	Clays.
Grayson	Stone (crushed).
Green	Do.
Hancock	Clays.
Hardin	Stone (crushed).
Harlan	Do.
Harrison	Do.
Hart	Do.
Henry	Do.
Jackson	Do.
Jefferson	Cement, stone (crushed), clays.
Jessamine	Stone (crushed), zinc.
Laurel	Stone (crushed).
Lee	Do.
Letcher	Do.
Lewis	Sand (industrial).
Livingston	Stone (crushed).
Logan	Do.
Madison	Do.
Marion	Do.
Mason	Lime, stone (crushed).
Meade	Stone (crushed).
Menifee	Do.
Mercer	Do.
Metcalfe	Do.
Monroe	Do.
Montgomery	Do.
Morgan	Do.
Muhlenberg	Do.
Nelson	Do.
Nicholas	Do.
Ohio	Do.
Oldham	Do.
Pendleton	Lime, stone (crushed).
Pike	Stone (crushed).
Powell	Stone (crushed), clays.
Pulaski	Do.
Rockcastle	Stone (crushed).
Scott	Do.
Simpson	Do.
Taylor	Do.
Todd	Do.
Trigg	Do.
Warren	Do.
Washington	Do.
Wayne	Do.
Whitley	Clays.
Wolfe	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Kentucky business activity

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	3,724	3,729	3,729
Total civilian labor force -----	do	1,715	1,696	1,690
Unemployment -----	percent	9.3	9.5	9.3
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	45.6	43.7	40.5
Nonmetallic minerals except fuels <sup>1</sup> -----	do	2.3	2.2	2.3
Coal mining -----	do	39.7	38.1	35.7
Manufacturing total -----	do	257.4	255.3	253.2
Primary metal industries -----	do	18.2	17.5	15.8
Stone, clay, and glass products -----	do	7.6	7.9	8.3
Chemicals and allied products -----	do	13.3	13.2	12.9
Petroleum and coal products -----	do	3.9	3.8	3.9
Construction -----	do	50.5	54.0	57.3
Transportation and public utilities -----	do	65.2	66.6	67.3
Wholesale and retail trade -----	do	282.1	297.0	302.5
Finance, insurance, real estate -----	do	55.1	56.9	59.5
Services -----	do	234.8	246.8	259.3
Government and government enterprises -----	do	223.0	230.0	237.4
Total -----	do	2,123.8	1,250.3	1,277.0
<b>Personal income:</b>				
Total -----	millions	\$38,506	\$40,118	\$41,902
Per capita -----	do	\$10,340	\$10,759	\$11,238
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	39.2	38.9	39.2
Total average hourly earnings, production workers -----	do	\$9.3	\$9.5	\$9.9
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$1,201	\$383	\$793
Nonfarm -----	do	\$26,268	\$27,662	\$28,978
Mining total -----	do	\$1,799	\$1,792	\$1,715
Nonmetallic minerals except fuels -----	do	\$51	\$52	\$46
Coal mining -----	do	\$1,623	\$1,598	\$1,546
Oil and gas extraction -----	do	\$125	\$142	\$123
Manufacturing total -----	do	\$6,423	\$6,586	\$6,716
Primary metal industries -----	do	\$601	\$579	\$560
Stone, clay, and glass products -----	do	\$175	\$190	\$207
Chemicals and allied products -----	do	\$441	\$453	\$461
Petroleum and coal products -----	do	\$162	\$170	\$172
Construction -----	do	\$1,509	\$1,598	\$1,762
Transportation and public utilities -----	do	\$2,042	\$2,106	\$2,165
Wholesale and retail trade -----	do	\$4,173	\$4,463	\$4,649
Finance, insurance, real estate -----	do	\$1,112	\$1,217	\$1,387
Services -----	do	\$4,540	\$4,961	\$5,415
Government and government enterprises -----	do	\$4,529	\$4,794	\$5,006
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do	13,276	13,770	13,503
Value of nonresidential construction <sup>4</sup> -----	millions	\$476.9	\$591.7	\$540.6
Value of State road contract awards <sup>5</sup> -----	do	\$318.0	\$322.0	\$353.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	1,054	1,092	1,200
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$257.2	\$267.6	\$267.3
Value per capita -----	do	\$69	\$72	\$72

<sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data do not add to total shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Hwy. and Heavy Construction Magazine, Jan. 1986, p. 32.

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

**Legislation and Government Programs.**—In 1986, 13 bills on mining and minerals, most of which pertained to fuels, were enacted.<sup>2</sup> None appeared to be of major significance to the State's mining industry as a whole.

The Kentucky Geological Survey, Section of Industrial and Metallic Minerals, conducted geologic and mining-related research. The State's leading nonfuel mineral in production value, crushed limestone, was

the subject of studies because of changing end-use markets. Traditionally, most of Kentucky's limestone was consumed in construction and agricultural applications. Increased use of limestone products is expected for control of sulfur dioxide emissions from coal-burning powerplants utilizing clean coal technologies such as flue-gas desulfurization and fluidized-bed combustion. During the year, investigations of potential sources of low-abrusion limestone

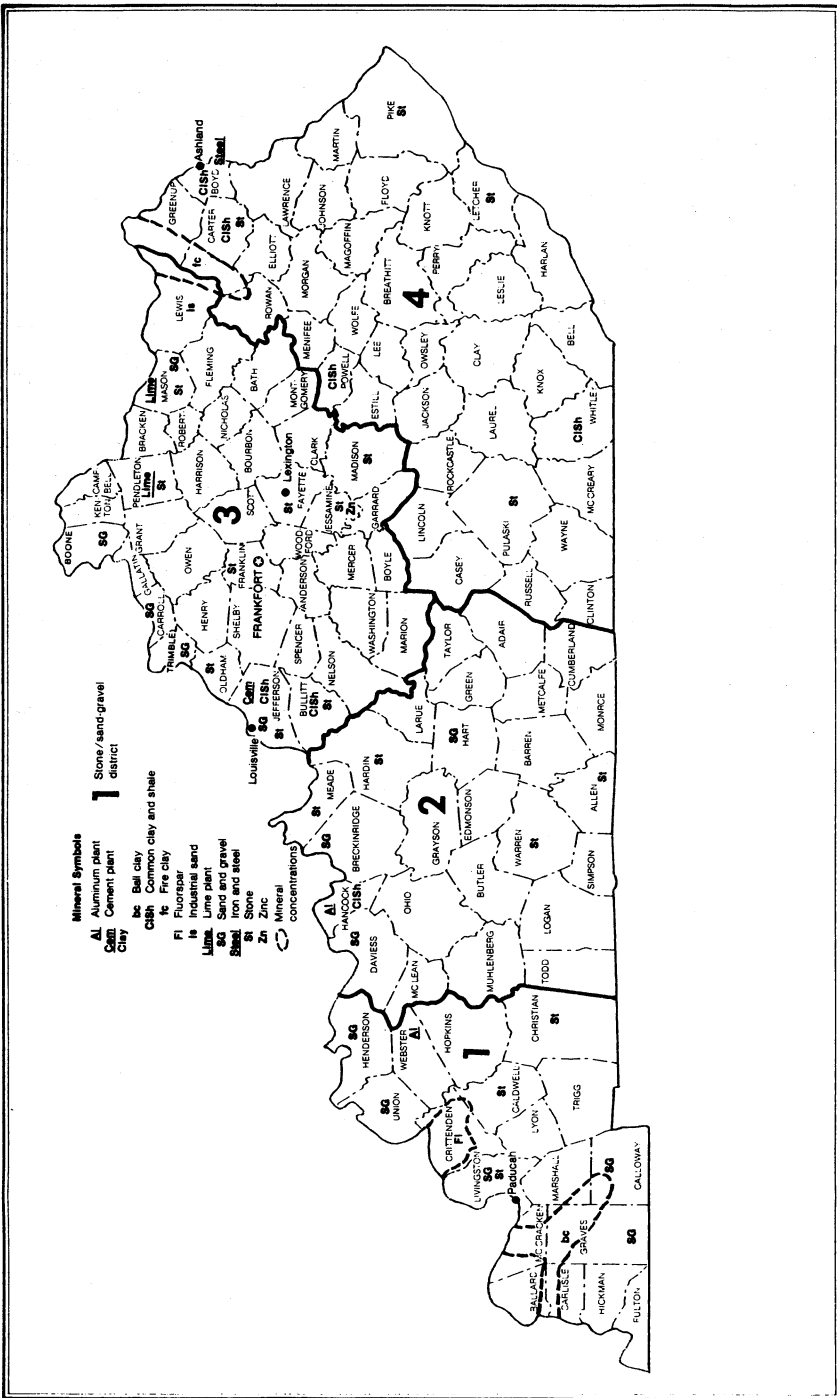


Figure 1.—Principal mineral-producing localities in Kentucky.

for use in fluidized-bed combustion plants burning coal with lower and medium sulfur content and of the chemical characteristics of limestone in central Kentucky were initiated. Limestone in southeastern Kentucky was also evaluated to determine applicability for use by the coal industry.<sup>3</sup>

The University of Kentucky's Mining and Mineral Resources and Research Institute

received a \$142,000 grant from the U.S. Bureau of Mines under the second year of Public Law 98-409. The university was also an affiliate of the Virginia Polytechnic Institute and State University, one of the five generic mineral technology centers in the United States with expertise in mine systems and ground control.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Some of the nonfuel minerals identified in table 1 are discussed in this section. Other commodities, processed or manufactured in Kentucky, included graphite (manufactured), mullite (synthetic), perlite (expanded), iron and steel slag, sulfur (elemental), and vermiculite (exfoliated); the combined value of these commodities was about \$52 million.

**Cement.**—Portland cement production in Kentucky was combined with that produced in Virginia and West Virginia to provide more information while avoiding disclosure of individual company data. In 1986, the three States, each operating one plant, produced 2.6 million short tons of portland cement utilizing 93.2% of capacity. Masonry cement data were also combined for the same reason, and the three States produced 294,000 tons. Kentucky produced masonry cement at one plant, Virginia at two, and West Virginia at one.

The State's only producer was Kosmos Cement Co. Inc., a subsidiary of Moore McCormack Cement Inc., at a plant near Louisville. Output increased by more than 20% in 1986 at the plant, which had an annual capacity of 670,000 short tons.

**Clays.**—Ball, common, and fire clays were mined in Kentucky. Most of the production was common clay used in brick manufacture.

**Lime.**—Dravo Corp. became Kentucky's sole lime producer with the purchase of the State's other operation, the Black River Lime Co. at Carntown, Pendleton County. Included in the \$25 million sale was an underground limestone mine, more than 150 million short tons of recoverable reserves, and a lime plant with an annual capacity of 660,000 short tons. At the facility, situated on the Ohio River about 30

miles east of Cincinnati, lime was produced that had a variety of applications, including industrial, chemical, and environmental. The acquisition increased the capacity of Dravo's subsidiary, Dravo Lime Co., by 40% to 2.3 million tons annually. Dravo was the Nation's leading lime producer in 1986, with production at the two plants in Kentucky and one plant each in Alabama, Louisiana, and Texas.

The Black River Lime Co. had previously been owned by Armco Inc. and LTV Steel Co. The sale reflected a trend by integrated steel companies to sell their lime and limestone operations. Shortages of these commodities have become less likely in the 1980's because of reduced steel capacity and production.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Kentucky's construction sand and gravel industry has remained stable in terms of production since 1980. Output averaged about 7 million short tons per year for the past 8 years. During that period, the highest production reported was 7.8 million tons in 1984 and the lowest, 5.5 million tons in 1983. The price per ton (plant f.o.b.) of construction sand and gravel has also remained about the same, increasing only 5% from that of 1980 to \$2.36 per ton in 1986. Nationally, for the same period, the average price rose 19% to \$3.11 per ton. Construction sand and gravel production was reported from 16 of the State's 120 counties; Boone, Daviess, Jefferson, and Trimble were the top producing counties.



**Table 4.—Kentucky: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	3,644	\$7,681	\$2.11
Plaster and guniting sands	W	W	3.63
Concrete products (blocks, bricks, pipe, decorative, etc.)	W	W	2.79
Asphaltic concrete aggregates and other bituminous mixtures	839	2,373	2.83
Road base and coverings	194	486	2.51
Fill	117	236	2.02
Snow and ice control	W	W	2.00
Other	612	2,054	3.36
Other unspecified <sup>1</sup>	1,790	4,153	2.32
Total <sup>2</sup> or average	7,194	16,986	2.36

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—A small quantity of industrial sand was produced by one company for use in coal washing.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Production for the last 3 years averaged 37.9 million short tons, about 6 million tons per year more than the average of the 3 preceding years. The construction and coal industries provided the demand, resulting in the higher output levels from 1984 through 1986.

A potentially expanding market for crushed limestone and lime was for use in clean coal technology. In one type of technology, termed "atmospheric fluidized-bed combustion" (AFBC), the calcium in limestone reacts with sulfur dioxide produced in coal combustion to form calcium sulfate in a solid state. In a demonstration project by the Tennessee Valley Authority, in excess of 90% of the sulfur was removed from coal with a 4.2% sulfur content using the AFBC process.<sup>4</sup>

In related research, calcium sulfate, the waste product of AFBC coal burning, was scheduled for testing as a road construction material. The University of Kentucky and State Transportation Cabinet planned the project for 1-1/3 miles in McCracken County in the summer of 1987.<sup>5</sup>

## METALS

No metals were mined in Kentucky. Metals manufactured in the State included primary aluminum, ferroalloys, and pig iron, which had a combined value of \$728 million.

**Aluminum.**—Output declined in 1986, primarily reflecting a 5-month labor strike by one of the State's two producers. However, Kentucky remained third nationally in primary aluminum production. Alcan Aluminum Ltd. operated its Sebree smelter at reduced capacity for 5 months during a labor strike resolved in October.

Expected to affect Alcan, along with the State's other producer, National-Southwire Aluminum Co., was a decision on a rate-hike request by Big Rivers Electric Corp. Both Alcan and National-Southwire purchased most of their electricity from Big Rivers and were the utility's largest customers. The Kentucky Public Service Commission was expected to rule on the rate-hike proposal in 1987.

**Iron and Steel.**—Pig iron and steel production declined in Kentucky. Nationally, output of these commodities also dropped. Two companies produced raw steel, Armco Inc. at Ashland and Newport Steel Corp. at Newport. Newport Steel purchased Kentucky Electric Steel Corp.'s minimill in Ashland for \$22 million and resumed production late in the year. Kentucky Electric had been permanently shut down in 1985.

**Ferroalloys.**—SKW Alloys Inc. began intermittent production of ferrosilicon powder at its Calvert City plant while continuing silicomanganese production.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Legislative Research Commission (Frankfort, KY). General Assembly Action. Inf. Bull. 154, May 1986, 80 pp.

<sup>3</sup>Dever, G. R., Jr., L. R. Thomas, and J. R. Moody. Limestone Resources for the Coal Industry: An Evaluation of the Newman Limestone (Mississippian) on the Cumberland Overthrust Block, Southeastern Kentucky. KY Geol. Surv., reprint 22, ser. 11, 1986, 13 pp.

<sup>4</sup>Bass, J. W., III. Development Described for Fluidized Bed Combustion at TVA's 20-MV Pilot Plant. Min. Eng. (Littleton, CO), v. 38, No. 4, Apr. 1986, pp. 240-244.

<sup>5</sup>Coal Mining. Coal Waste Products May Make Good Roads. V. 24, No. 5, May 1987, p. 17.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum (primary):</b>			
Alcan Aluminum Ltd -----	Sebree, KY 42555 -----	Smelter -----	Webster.
National-Southwire Aluminum Co.	Box M Hawesville, KY 42348	-----do-----	Hancock.
<b>Cement:</b>			
Koemos Cement Co. Inc., <sup>1 2</sup> a subsidiary of Moore McCormack Cement Inc.	Dixie Hwy. Box 72319 Louisville, KY 40272	Plant -----	Jefferson.
<b>Clays:</b>			
<b>Ball clay:</b>			
Kentucky-Tennessee Clay Co	Box 449 Mayfield, KY 42066	Mines and plant --	Carlisle and Graves.
Old Hickory Clay Co -----	Box 66 Hickory, KY 42051	-----do-----	Graves.
<b>Common clay:</b>			
General Shale Products Corp	Box 3547 CRS Johnson City, TN 37602	Mine and plant --	Jefferson.
Kentucky Solite Corp -----	Box 27211 Richmond, VA 23261	-----do-----	Bullitt.
U.S. Brick Inc., Sipple Div --	Box 567 Stanton, KY 40380	-----do-----	Powell.
<b>Fire clay:</b>			
Ford Burchett Clay Co -----	Route 1, Box 850 Olive Hill, KY 41164	Mine -----	Carters.
<b>Ferroalloys:</b>			
SKW Alloys Inc -----	Box 217 Calvert City, KY 42029	Plant -----	Marshall.
<b>Graphite (synthetic):</b>			
Ashland Petroleum Co., Carbon Fibers Div. <sup>3</sup>	Ashland, KY 41101 -----	-----do-----	Boyd.
Sigri Carbon Corp -----	Box 229 Hickman, KY 42050	-----do-----	Fulton.
Superior Graphite Co -----	Box 535 Hopkinsville, KY 42240	-----do-----	Christian.
<b>Iron and steel (pig iron):</b>			
Armco Inc -----	Middletown, OH 45202 ---	-----do-----	Boyd.
Newport Steel Corp -----	9th & Lowell Sts. Newport, KY 41072	Plants -----	Campbell.
<b>Lime:</b>			
Dravo Lime Co., a subsidiary of Dravo Corp. <sup>2</sup>	One Gateway Center Pittsburgh, PA 15222	Mines and plants--	Mason and Pendleton.
<b>Perlite (expanded):</b>			
International Permalite Co -----	300 North Haven Ave. Ontario, CA 91762	Plant -----	Boone.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Evansville Materials Inc -----	Box 249 Tell City, IN 47586	Dredges -----	Daviess.
Martin Marietta Corp. <sup>2</sup> -----	Box 30013 Raleigh, NC 27622	Pits -----	Carroll, Jefferson, Oldham.
Northern Kentucky Aggregates.	11641 Mosteller Rd. Cincinnati, OH 45226	-----do-----	Boone.
<b>Industrial:</b>			
Industrial Supply House of Greenup Inc.	Box 647 422 Harrison St. Greenup, KY 41144	Pit -----	Lewis.
<b>Stone (crushed):</b>			
The Kentucky Stone Co -----	400 Sherburn Lane Louisville, KY 40207	Underground mines, quarries, plants.	Various.
Reed Crushed Stone Co -----	Box 35 Gilbertsville, KY 42044	Quarry and plant	Livingston.
Rogers Group Inc -----	Box 237 Crestwood, KY 40014	Quarries and plants.	Bullitt, Christian, Grayson, Oldham.
Three Rivers Rock Co -----	Box 218 Smithland, KY 42081	Quarry and plant	Livingston.
<b>Vermiculite:</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Campbell.

<sup>1</sup>Also clays.<sup>2</sup>Also stone.<sup>3</sup>Also sulfur.



# The Mineral Industry of Louisiana

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

By James R. Boyle<sup>1</sup> and Charles G. Groat<sup>2</sup>

The value of Louisiana's nonfuel mineral production in 1986 was \$446.8 million, a decrease of nearly \$74 million from that of 1985, the first decline in value since 1982. The State led the Nation in salt output, was

second in Frasch sulfur output, and was fifth in the production of recovered sulfur from oil refineries. Salt and Frasch sulfur remained the major nonfuel mineral commodities produced in the State.

Table 1.—Nonfuel mineral production in Louisiana<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons --	547	<sup>2</sup> \$10,858	334	\$7,017	332	\$7,670
Gem stones -----	NA	<sup>e</sup> 1	NA	<sup>e</sup> 1	NA	1
Salt ----- thousand short tons --	13,101	112,142	<sup>r</sup> 12,271	<sup>r</sup> 137,273	11,608	103,611
Sand and gravel:						
Construction ----- do -----	17,040	54,664	<sup>e</sup> 15,000	<sup>e</sup> 48,000	14,292	46,134
Industrial ----- do -----	266	3,757	267	3,838	256	4,225
Stone (crushed) ----- do -----	<sup>e</sup> 4,100	<sup>e</sup> 19,500	<sup>s</sup> 4,820	<sup>s</sup> 25,956	<sup>e</sup> 35,400	<sup>e</sup> 325,300
Sulfur (Frasch) -- thousand metric tons --	2,007	W	1,698	W	1,602	W
Combined value of cement (masonry, 1984-85, and portland), clays (bentonite, 1984), gypsum (1984-85), lime, stone (crushed miscellaneous, 1985-86), and values indicated by symbol W -----	XX	310,548	XX	298,501	XX	259,857
Total -----	XX	511,470	XX	<sup>r</sup> 520,586	XX	446,798

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes bentonite; value included with "Combined value" figure.

<sup>3</sup>Excludes crushed miscellaneous stone; value included with "Combined value" figure.

**Table 2.—Nonfuel minerals produced in Louisiana in 1985, by parish<sup>1</sup>**

Parish	Minerals produced in order of value
Allen -----	Sand (industrial).
Ascension -----	Salt.
Assumption -----	Do.
Bienville -----	Clays.
Caddo -----	Do.
Calcasieu -----	Salt.
Cameron -----	Do.
East Baton Rouge -----	Sand (industrial).
Iberia -----	Salt.
Iberville -----	Do.
Jefferson -----	Sulfur, salt.
Natchitoches -----	Clays.
Orleans -----	Cement, stone (crushed), lime.
Plaquemines -----	Sulfur, salt.
Pointe Coupee -----	Clays.
Red River -----	Sand (industrial).
St. Helena -----	Clays.
St. Martin -----	Salt.
St. Mary -----	Salt, stone (crushed), lime.
St. Tammany -----	Clays.
Webster -----	Sand (industrial).
Winn -----	Stone (crushed), gypsum.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for parishes not listed.

<sup>2</sup>Data not available by parish for minerals listed.

**Trends and Developments.**—The Louisiana economy, which had been stagnant since 1982, turned downward in 1986; industrial production dropped at an annual rate of more than 6%. The State's economic base, which has been concentrated on extracting and processing raw materials, has also been vulnerable to international economic developments. In the last decade, Louisiana's international trade has eroded seriously, affecting industrial producers that serve world markets.<sup>3</sup> The decrease in oil prices and exploration activities adversely affected the entire Louisiana economy. In the last 5 years, jobs declined by 5% in the State but increased 11% nationally. Since 1981, over 150,000 jobs have been lost in mining, construction, and manufacturing due to the slumping energy sector. This adverse movement in the economy had a serious impact on mineral production in the State.

As reported by the Louisiana Department of Revenue, severance tax receipts for 1986 totaled nearly \$3.4 million, down from \$3.8 million in 1985. Minerals taxed included brine (\$51,000), gravel (\$472,000), salt (\$325,000), sand (\$483,000), shell (\$278,000), stone (\$7,400), and sulfur (\$1.8 million).

During the year, 1,472,000 short tons of cement and clinker was imported through the Port of New Orleans compared with 966,000 tons in 1985. The majority of the

cement and clinker came from Canada, France, Mexico, and Spain. Of the total, over 400,000 short tons was clinker. Other minerals handled through the Port of New Orleans included coal, ferroalloys, gypsum, limestone, phosphate, salt, sand, and various nonferrous ores and concentrates. Imports of iron ore increased from about 1 million long tons in 1985 to 1.6 million long tons in 1986.

Minerals were the predominant cargo handled at the port at Burnside. The facilities handled 3.5 million short tons of material during 1986, down from 3.8 million short tons in 1985. Minerals included alumina, bauxite, cement, chrome, coal, coke, ferroalloys, fluorspar, iron ore, manganese ore, pig iron, rutile, vermiculite, and zircon. Major minerals were alumina, bauxite, cement, and coal.

Major minerals shipped through the port at Lake Charles were barite, cement and crushed stone.

Expansions and/or modifications to production facilities of nonfuel mineral-related industries, as announced by the Louisiana Department of Commerce, totaled 26 expansions valued at over \$100 million. The data were as follows: alumina chemicals, 5 (\$26.3 million); anhydrous ammonia, 2 (\$12.5 million); carbon black and coke, 5 (\$3.3 million); chlorine and caustic soda, 6 (\$39.9 million); fluorocarbons, 1 (\$600,000); foundry castings, 3 (\$8 million); primary metals, 1 (\$5.6 million); nitrogen, 1 (\$4 million); silica, 1 (\$860,000); and sulfuric acid, 1 (\$1.8 million).

**Legislation and Government Programs.**—During the year, the State enacted legislation to create a Surface & Mining Reclamation Fund by imposing a severance tax of 8 cents per short ton. Additionally, legislation was passed to authorize the Louisiana Department of Commerce to sell bonds to finance a project to deepen to 45 feet the Mississippi River from the mouth up to Baton Rouge.

Projects at the Louisiana Geological Survey (LGS) in 1986 included studies on (1) the erosional trends along the coastline, (2) coastline sedimentary processes of deposition, (3) subsurface sand deposits in nearshore waters, (4) coastal protection measures, (5) shoreline mapping, and (6) geology of the State's Continental Shelf and barrier island shorelines.

LGS, in cooperation with representatives from Alabama, Mississippi, and Texas, planned to explore the Gulf of Mexico's floor to determine what nonfuel mineral

Table 3.—Indicators of Louisiana business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands -----	4,462	4,486	4,501
Total civilian labor force -----	do -----	1,941	1,986	1,988
Unemployment -----	percent -----	10.0	11.5	13.1
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands -----	81.6	81.2	63.8
Nonmetallic minerals except fuels -----	do -----	3.1	2.9	3.0
Oil and gas extraction -----	do -----	78.5	78.2	60.9
Manufacturing total -----	do -----	182.4	178.0	166.7
Primary metal industries -----	do -----	3.6	3.4	2.9
Stone, clay, and glass products -----	do -----	8.1	7.0	6.1
Chemicals and allied products -----	do -----	29.4	28.1	26.1
Petroleum and coal products -----	do -----	13.0	12.6	12.4
Construction -----	do -----	118.3	105.2	90.7
Transportation and public utilities -----	do -----	118.6	116.0	107.9
Wholesale and retail trade -----	do -----	383.6	383.3	370.2
Finance, insurance, real estate -----	do -----	83.9	85.4	85.6
Services -----	do -----	314.5	320.0	318.4
Government and government enterprises -----	do -----	318.6	322.4	320.8
Total -----	do -----	1,601.5	1,591.2	1,524.1
<b>Personal income:</b>				
Total -----	millions -----	\$48,843	\$50,540	\$50,382
Per capita -----		\$10,946	\$11,287	\$11,193
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		41.6	41.7	41.8
Mining -----		46.9	47.0	46.3
Total average hourly earnings, production workers -----		\$10.1	\$10.4	\$10.6
Mining -----		\$11.2	\$11.2	\$11.6
<b>Earnings by industry:<sup>2</sup></b>				
Farm income -----	millions -----	\$428	\$314	\$350
Nonfarm -----	do -----	\$36,134	\$36,899	\$35,791
Mining total -----	do -----	\$2,792	\$2,917	\$2,322
Nonmetallic minerals except fuels -----	do -----	\$87	\$89	\$91
Oil and gas extraction -----	do -----	\$2,694	\$2,816	\$2,215
Manufacturing total -----	do -----	\$5,184	\$5,238	\$5,056
Primary metal industries -----	do -----	\$112	\$103	\$83
Stone, clay, and glass products -----	do -----	\$187	\$160	\$141
Chemicals and allied products -----	do -----	\$1,187	\$1,189	\$1,155
Petroleum and coal products -----	do -----	\$650	\$661	\$661
Construction -----	do -----	\$3,375	\$3,082	\$2,704
Transportation and public utilities -----	do -----	\$3,355	\$3,375	\$3,229
Wholesale and retail trade -----	do -----	\$5,972	\$6,023	\$5,837
Finance, insurance, real estate -----	do -----	\$1,799	\$1,905	\$2,024
Services -----	do -----	\$7,536	\$7,936	\$8,127
Government and government enterprises -----	do -----	\$5,958	\$6,242	\$6,308
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup> -----		28,073	18,766	10,501
Value of nonresidential construction <sup>3</sup> -----	millions -----	\$1,260.5	\$1,226.1	\$862.9
Value of State road contract awards <sup>4</sup> -----	do -----	\$502.2	\$715.0	\$947.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons -----	2,730	2,485	2,012
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions -----	\$511.5	\$520.6	\$446.8
Value per capita -----		\$115	\$116	\$99

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Data do not add to total shown because of independent rounding.<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

deposits are available that could be developed economically. Possible minerals in quantities large enough for development include heavy minerals, sand and gravel, shale, and sulfur.

The Mineral Resources Institute of the Louisiana State University received a grant from the U.S. Bureau of Mines under title

III of Public Law 95-87, which is designed to encourage the training of mining engineers and other scientists involved in mineral-related studies. The Institute sponsored research on areas of mining and mineral resources; the majority were energy related.

The issue of offshore oil and gas revenues from Federal leases to be shared with Loui-

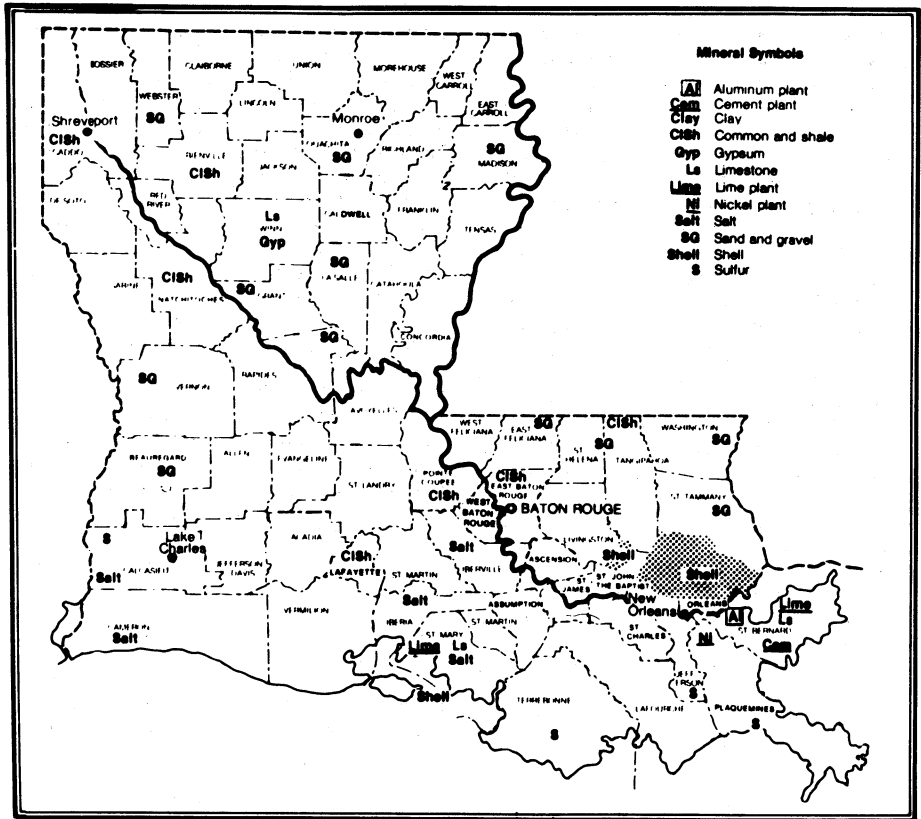


Figure 1.—Principal mineral-producing localities in Louisiana.

siana and other coastal States under section 8(g) of the Outer Continental Shelf Lands Act of 1978 was settled during the year. Legislation was enacted giving coastal States 27% of all revenues earned in the zone adjacent to their borders from September 1978 to October 1986. Distribution of income earned after October 1986 will be determined on the basis of the portion of a Federal tract actually within the zone. The largest payment, \$615 million, was made to the State of Louisiana. Of that total, \$572 million was from bonuses, interest, and rents; \$43 million was in royalties.

The Water Resources Development Act of 1986 authorized a 55-foot ship channel in the Mississippi River from the Gulf of Mexico to Baton Rouge. The State and the Federal Government signed a cost-sharing agreement for construction of the first phase of the project, a 45-foot ship channel; construction was scheduled to start in 1987. Estimated cost of the first phase was \$150 million; the State's share was \$48.7 million. Deepening of the ship channel would assist bulk carriers, especially those transporting coal and other minerals.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Barite.**—Nine plants in Louisiana crush and ground both imported and domestic barite for use in oil and gas drilling; output decreased because of decreased exploration activities. The major portion of imported

barite ore was from China.

**Calcium Chloride (Synthetic).**—Synthetic calcium chloride was produced by Texas United Chemical Corp. at its plant in Lake Charles; the facility used hydrochloric acid and limestone. Production decreased but value increased. Synthetic calcium chlo-

ride was used in concrete setup, dust control, oil and gas drilling, road deicing, and other uses. Texas United announced a \$2.8 million expansion of its facility.

**Cement.**—Output of portland cement decreased as construction activities remained low throughout the year; no production of masonry cement was reported. Lone Star Industries Inc. ground imported clinker at its facility in New Orleans. Imports of cement and clinker through the Port of New Orleans increased over 50% in 1986. Because of the lower prices for imported cement and clinker, no cement kilns operated along the gulf coast. Shipments of imported cement up the Mississippi River also affected inland cement facilities: Prices of portland cement decreased. Major uses were ready-mixed concrete, concrete products, building materials, and highway construction.

**Clays.**—Louisiana's clay industry produced only common clay; output remained steady and unit values increased. Common clay was mined by five companies at seven mines in five parishes. The major end use of common clay was in the manufacture of lightweight aggregate for use in concrete block and structural concrete. With demand tied closely to construction activities, the continued slump in construction kept output of common clay at a relatively low level. The average price of common clay increased from \$21.03 per short ton in 1985 to \$23.10 per ton in 1986.

Table 4.—Louisiana: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1982	326	16,216
1983	1,505	10,793
1984	547	10,858
1985	334	7,017
1986	332	7,670

<sup>1</sup>Excludes bentonite.

**Fluorspar.**—Byproduct fluosilicic acid, from the production of phosphoric acid, was produced by Agrico Chemical Co. and Freeport Chemical Co. at plants in Donaldsville and Uncle Sam, respectively.

**Gypsum.**—National Gypsum Co., Jefferson Parish, and USG Corp., Orleans Parish, produced calcined gypsum from crude material shipped into Louisiana. Calcined gypsum output and value decreased.

**Lime.**—Output of lime remained at a

relatively low level; quicklime output increased and that of hydrated lime decreased. USG produced quicklime and hydrated lime from shells at its facility in New Orleans; Dravo Lime Co. also produced quicklime and hydrated lime at its plant in Morgan City. Output was used in water purification and softening, road stabilization, petrochemicals, and oil and grease.

**Nitrogen.**—Louisiana's annual production capacity of anhydrous ammonia was over 7 million short tons, which represented over 40% of national capacity. Of the 43 domestic producers of anhydrous ammonia, 14 had facilities in Louisiana. Three companies announced expansion programs totaling nearly \$17 million.

**Perlite (Expanded).**—Filter-Media Co. Inc. of Louisiana expanded crude perlite that was shipped into the State; the facilities are in Reserve, St. John the Baptist Parish. Output of expanded perlite remained steady. The perlite was used as a filter aid, for insulation, and in concrete aggregate.

**Salt.**—Louisiana remained the leading producer of salt nationally with approximately one-third of the Nation's output. Production decreased almost 5%, but value decreased nearly 25%. Twelve companies recovered salt at 13 operations in 11 parishes. Three were underground operations with the remaining being solution mines.

Markets for salt remained firm as prices decreased. Chlorine and caustic soda represented the largest domestic market for salt in 1986.

Diamond Crystal Salt Co. shut down its Jefferson Island processing facility early in the year. An increase in the cost of purchasing rock and a decrease in selling prices were cited as reasons for the closure.

**Sand and Gravel.**—Louisiana produced construction and industrial sand and gravel in 1986; output decreased slightly.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was one of the major commodities in value among the nonfuel minerals produced in the State. Because of depressed economic conditions, output remained below levels achieved during the late 1970's. Most facilities operated at less than capacity; no individual pit



produced more than 1.5 million short tons. Production was at 104 operations by 77 companies in 24 parishes. Leading parishes, in order of output, were St. Tammany,

Washington, St. Helena, and Webster. Most of the material was shipped by truck, with lesser amounts by rail and water.

**Table 5.—Louisiana: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	3,084	\$13,113	\$4.32
Plaster and gunitite sands -----	W	W	3.95
Asphaltic concrete aggregates and other bituminous mixtures -----	500	2,249	4.50
Road base and coverings <sup>1</sup> -----	381	1,243	3.26
Fill -----	1,350	1,704	1.26
Other unspecified <sup>2</sup> -----	9,028	27,825	3.08
Total or average -----	<sup>3</sup> 14,292	46,134	3.23

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

<sup>1</sup>Includes road and other stabilization (lime).

<sup>2</sup>Includes roofing granules, production reported without a breakdown by use, estimates for nonrespondents, and data indicated by symbol W.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Four companies mined industrial sand in four parishes in 1986 with output decreasing. Primary markets in the glass industry remained down, but the foundry market improved. Operations were relatively small with output below capacity levels.

United States Borax & Chemical Corp. purchased Ottawa Silica Co., which included six silica sand operations, for \$46 million. One operation, Louisiana Industrial Sand Co., is in Dubberly.

**Stone (Crushed).**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Output of crushed stone in Louisiana, which included anhydrite and shell, has been on a declining curve since 1973; however, estimates for 1986 indicate an increase in output. Demand, however, has not declined as much and has been filled by out-of-State operations through local distribution points.

Shell continued to account for over 90% of the State's total output of crushed stone and more than one-half of the national output of shell. Three companies produced shell in Orleans and St. Mary Parishes. Anhydrite was mined at a quarry in Winn Parish. Stone was used in a variety of aggregate uses, and anhydrite was used primarily as a road base.

Environmental opposition to dredging in lakes and coastal areas of Louisiana continued. In a court decision, the U.S. Corps of Engineers was ordered to submit an environmental impact statement of dredging

operations in Lakes Pontchartrain and Maurepas and along Louisiana's coast. Dredging will continue during the impact study, but permits will not be renewed or extended when they expire at the end of 1987 unless the study is completed. Environmentalists contended that dredging stirs up sediment, depletes oxygen and causes long-term ecological damage, including coastline erosion.

Crushed stone from out of State continued to meet most of the demands in Louisiana. Crushed stone from Arkansas was shipped by rail into North Louisiana; quarries in Kentucky and Missouri maintained distribution points along the Mississippi River. Additionally, stone was imported from several countries through the various ports along the coastline. TXTX Corp., Port Arthur, TX, and Foster Yeoman Ltd., Somerset, England, United Kingdom, signed a long-term agreement to supply and distribute crushed granite along the gulf coast. TXTX was the operator of the Greens Port terminal in Houston, TX.

**Sulfur.**—Louisiana ranked second in the Nation in production of Frasch sulfur and fifth in recovered elemental sulfur. Frasch sulfur shipments decreased along with unit prices. In terms of value, sulfur remained the leading nonfuel mineral in the State. Output decreased for the second year and remained relatively low because of the weak demand for phosphate fertilizer. Freeport Minerals Co. operated its Garden Island Bay and Grand Isle facilities and continued plans to reactivate its offshore mine in Caminada Pass. The facility, scheduled to reopen in 1987, would add 600,000 metric tons per year of capacity. The operation, closed for nearly 18 years, contains a

reported 6 metric tons of recoverable reserves. Freeport-McMoRan Resources Partners agreed to acquire Agrico Chemical, which included a phosphate fertilizer plant at Donaldsonville. Freeport-McMoRan also agreed to acquire 88% of Beker Industries' phosphate operation at Taft. In mid-1986, Freeport-McMoRan acquired American Cyanamid Co.'s diammonium phosphate plant at Luling.

The U.S. Department of the Interior conducted preliminary investigations into the

possibility of selling new sulfur leases in the central and western regions of the Outer Continental Shelf in the Gulf of Mexico. An environmental impact statement would be required, and it would be 2 years before an offering could be made.

Nine oil companies recovered elemental sulfur from nine refineries in seven parishes. Output was 527,000 tons valued at \$57.4 million, compared with 403,000 tons valued at \$45.1 million in 1985.

**Table 6.—Louisiana: Sulfur produced and shipped from Frasch mines**

(Thousand metric tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1982	1,312	1,239	W
1983	1,286	1,643	W
1984	1,937	2,007	W
1985	2,071	1,698	W
1986	1,579	1,602	W

W Withheld to avoid disclosing company proprietary data.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. exfoliated vermiculite at its plant in New Orleans. Principal end uses were in concrete and plaster aggregates, horticulture, loose fill insulation, and block insulation.

## METALS

**Aluminum.**—Louisiana was 1 of 17 States with aluminum-producing facilities; the facilities have been idle since 1983. Reduced demand and low price kept Kaiser Aluminum & Chemical Corp.'s Chalmette smelter shut down; Kaiser reportedly wrote off 131,000 short tons of capacity at the facility. Kaiser permanently shut down its alumina facility at Baton Rouge, but kept its chemical plants at Gramercy and Baton Rouge in operation. Kaiser announced expenditures of over \$25 million in expansion and renovation at its two chemical plants: \$4.4 million at Baton Rouge and \$21 million at Gramercy.

Ormet Corp.'s alumina refinery at Burnside remained closed for the entire year, and the corporation purchased required raw materials on the open market. During the year, Ohio River Associates announced it had agreed to purchase Ormet from Consolidated Aluminum Corp. and Revere Copper and Brass Inc.

**Iron and Steel.**—Bayou Steel Corp. operated the only minimill in the State at LaPlace. RSR Corp. purchased the facility from Voest-Alpine AG for \$76 million. Because of the low cost of river transportation,

Bayou's market area extended to Chicago, IL, and Pittsburgh, PA. The minimill had a melting capacity of 700,000 short tons and a rolling capacity of 400,000 tons. Bayou plans to spend about \$5 million to increase rolling capacity to 700,000 tons and increase melting capacity.

Iron and steel foundries remained a relatively small industry in the State. Nearly all raw materials required for these foundries, including coal, limestone, sand, and scrap, came from sources in the Southeast. According to the Directory of Louisiana Manufacturers, 12 gray iron foundries, 6 steel foundries, and 1 malleable iron foundry operated in the State. Of these 19 facilities, only 8 employed more than 100 people.

**Nickel.**—AMAX Inc.'s Port Nickel nickel refinery closed in November 1985. AMAX, in a joint venture with CRI Ventures, began reclamation of metallics from spent petroleum catalysts at its plant in 1986. Initial production was expected to be about 125 short tons of molybdenum and 106 short tons of vanadium pentoxide. The reclamation process was developed and patented by AMAX and was utilized at the plant because of available facilities and the large number of gulf coast refineries that utilize catalysts.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>State geologist, Louisiana Geological Survey, Baton Rouge, LA.

<sup>3</sup>Federal Reserve Bank of Atlanta. Economic Review. Nov.-Dec. 1986, pp. 47-60.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	Parish
<b>Aluminum:</b>			
Kaiser Aluminum & Chemical Corp	Box 1600 Chalmette, LA 70043	Plant -----	St. Bernard.
<b>Cement:</b>			
Lone Star Industries Inc -----	Box 12449 Dallas, TX 75225	----do-----	Orleans.
<b>Clays:</b>			
Athens Brick Co. Inc.-----	Box 70 Athens, TX 75751	Mines and plant --	Caddo.
Big River Industries Inc.-----	Box 66377 Baton Rouge, LA 70806	Mine and plant --	Pointe Coupee.
<b>Gypsum:</b>			
National Gypsum Co.-----	Box 128 Westwego, LA 70094	Plant -----	Jefferson.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	----do-----	Orleans.
<b>Lime:</b>			
Dravo Lime Co -----	One Gateway Center Seventh Floor Pittsburgh, PA 15222	----do-----	St. Mary.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	----do-----	Orleans.
<b>Salt:</b>			
Domtar Chemicals Inc., Shifto Salt Div	4825 North Scott Shiller Park, IL 60176	Underground mine	St. Mary.
The Dow Chemical Co -----	Midland, MI 48640 -----	Brine wells -----	Iberville.
International Salt Co -----	Clarks Summit, PA 18411	Underground mine	Iberia.
Morton Salt Co -----	110 North Wacker Dr. Chicago, IL 60606	----do-----	Do.
PPG Industries Inc.-----	Box 1000 Lake Charles, LA 70604	Brine wells -----	Calcasieu.
<b>Sand and gravel:</b>			
Gifford-Hill & Co. Inc -----	Box 6615 Shreveport, LA 71136	Dredges, pits, plants.	Jefferson Davis, Rapides, Tangi- paha, Webster.
Louisiana Sand and Gravel Co -----	Box 963 Baton Rouge, LA 70821	Dredge and plant --	St. Helena.
Standard Gravel Co. Inc.-----	Route 7, Box 53 Franklinton, LA 70438	Dredges and plants	St. Tammany and Washington.
Texas Industries Inc -----	Box 5472 Alexandria, LA 71301	Dredges, pits, plants.	Beauregard, Grant, La Salle, Ouachita, Rap- ides, St. Tam- many.
<b>Stone (crushed, 1985):</b>			
Winn Rock Inc -----	Box 790 Winnfield, LA 71483	Quarry and plant --	Winn.
Pontchartrain Dredging Corp -----	Box 8005 New Orleans, LA 70182	----do-----	Do.
Southern Industries Corp -----	Box 2068 Mobile, AL 36652	Dredges -----	Orleans and St. Mary.
<b>Sulfur:</b>			
<b>Native:</b>			
Freeport Minerals Co -----	200 Park Ave. New York, NY 10166	Frasch process ---	Jefferson and Plaquemines.
<b>Recovered:</b>			
Cities Service Oil Co -----	Box 300 Tulsa, OK 74102	Refinery -----	Calcasieu.
Exxon Co. U.S.A. -----	Box 551 Baton Rouge, LA 70821	Plant -----	East Baton Rouge.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	----do-----	Orleans.

# The Mineral Industry of Maine

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

By Donald K. Harrison<sup>1</sup> and Walter Anderson<sup>2</sup>

The value of Maine's mineral production in 1986 was \$52.9 million, an \$11.8 million increase over that of 1985. The increase was primarily the result of increased consumption in cement, construction sand and gravel, and crushed stone. Cement accounted for the greatest portion of the State's mineral commodity value, followed by construction sand and gravel, crushed stone, and dimension stone.

Nonresidential construction activity in Maine was especially strong in 1986, increasing nearly 54% over that of 1985. Also, new road construction and State infrastructure repairs on bridges, roads, and water systems in the corridor between Boston, MA, and Portland, ME, which exceeded the regional average, resulted in increased aggregate sales in the area.

Table 1.—Nonfuel mineral production in Maine<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons..	43	\$97	50	\$100	46	\$90
Gem stones -----	NA	<sup>e</sup> 400	NA	<sup>e</sup> 400	NA	200
Sand and gravel (construction) thousand short tons..	7,885	19,228	<sup>e</sup> 7,200	<sup>e</sup> 18,000	8,572	22,843
Stone (crushed) ----- do.-----	<sup>e</sup> 1,300	<sup>e</sup> 4,400	1,459	5,114	<sup>e</sup> 1,600	<sup>e</sup> 4,400
Combined value of cement, garnet (abrasive), peat (1984, 1986), and stone (dimension) --	XX	<sup>f</sup> 14,088	XX	17,494	XX	25,326
Total -----	XX	<sup>f</sup> 38,213	XX	41,108	XX	52,859

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Maine in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Androscoggin	Clays.
Aroostook	Stone (crushed).
Cumberland	Stone (crushed), clays.
Franklin	Abrasives.
Hancock	Stone (dimension).
Kennebec	Stone (crushed).
Knox	Cement, stone (crushed).
Penobscot	Stone (crushed).
Washington	Stone (dimension).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Maine business activity

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Employment and labor force, annual average:</b>			
Population	1,158	1,165	1,173
Total civilian labor force	551	553	562
Unemployment	6.1	5.4	5.3
<b>Employment (nonagricultural):</b>			
Mining total	0.2	0.1	0.1
Manufacturing total	110.6	105.9	103.9
Stone, clay, and glass products <sup>1</sup>	1.0	1.3	1.5
Chemicals and allied products <sup>1</sup>	.9	.9	.9
Construction	20.4	23.4	26.8
Transportation and public utilities	19.1	19.3	19.3
Wholesale and retail trade	101.3	108.0	115.3
Finance, insurance, real estate	19.6	20.9	22.7
Services	90.6	95.8	101.9
Government and government enterprises	83.9	84.9	87.1
Total	445.7	458.4	477.1
<b>Personal income:</b>			
Total	\$12,966	\$13,815	\$15,007
Per capita	\$11,201	\$11,857	\$12,790
<b>Hours and earnings:</b>			
Total average weekly hours, production workers	39.9	40.0	40.6
Total average hourly earnings, production workers	\$8.0	\$8.4	\$8.7
<b>Earnings by industry:<sup>3</sup></b>			
Farm income	\$126	\$100	\$84
Nonfarm	\$8,838	\$9,482	\$10,420
Mining total	\$25	\$34	\$30
Manufacturing total	\$2,384	\$2,387	\$2,500
Stone, clay, and glass products	\$21	\$29	\$35
Chemicals and allied products	\$23	\$23	\$23
Construction	\$606	\$682	\$828
Transportation and public utilities	\$556	\$565	\$603
Wholesale and retail trade	\$1,431	\$1,578	\$1,783
Finance, insurance, real estate	\$378	\$420	\$532
Services	\$1,734	\$1,905	\$2,130
Government and government enterprises	\$1,646	\$1,776	\$1,856
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup>	6,570	8,113	9,554
Value of nonresidential construction <sup>4</sup>	\$166.9	\$300.5	\$367.4
Value of State road contract awards <sup>5</sup>	\$72.0	\$73.0	\$59.0
Shipments of portland and masonry cement to and within the State	275	293	348
<b>Nonfuel mineral production value:</b>			
Total crude mineral value	\$38.2	\$41.1	\$52.9
Value per capita	\$33	\$35	\$45

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

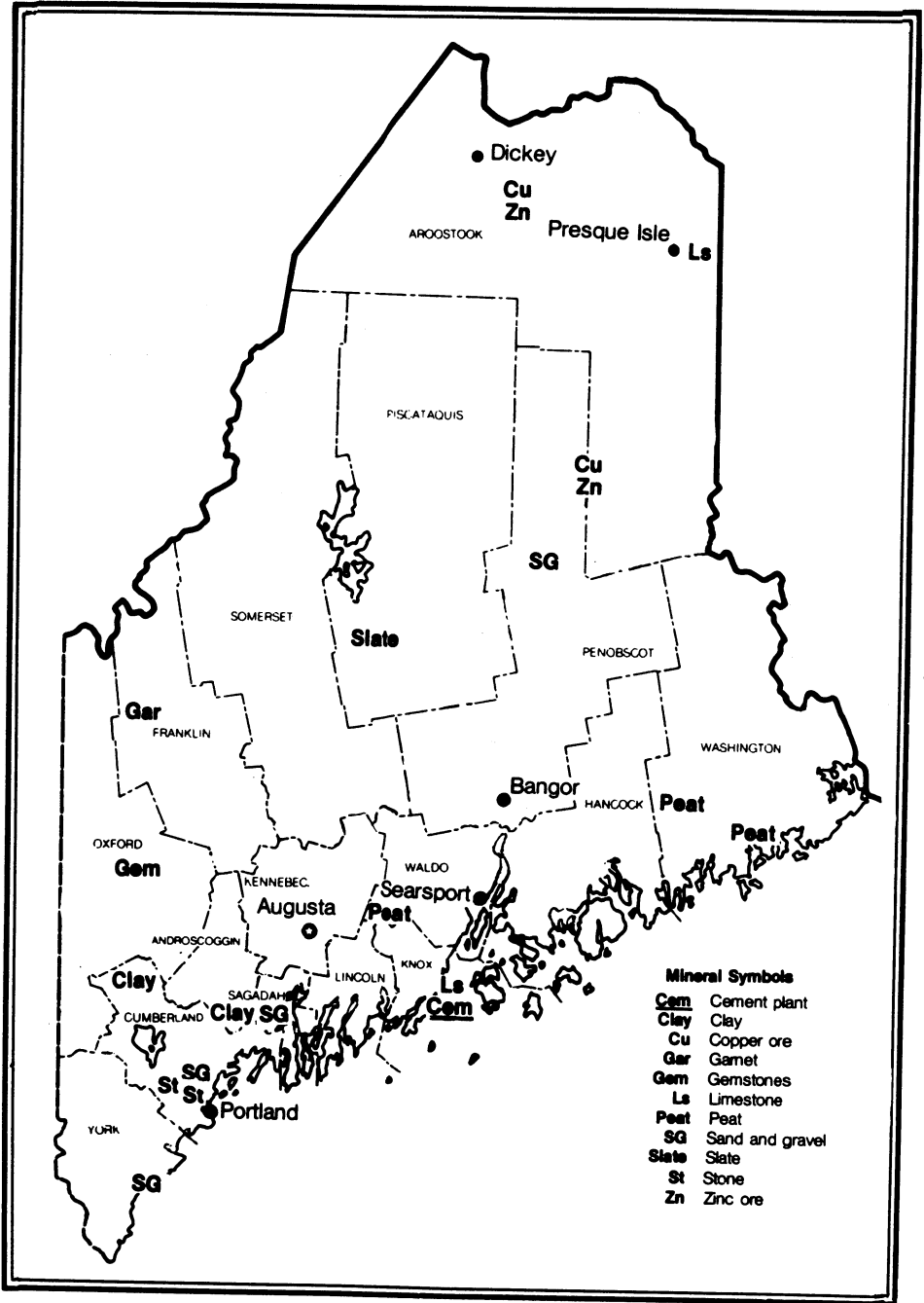


Figure 1.—Principal mineral-producing localities in Maine.

**Exploration Activities.**—Maine's mineral exploration activity declined slightly in 1986. Noranda Exploration Inc. discontinued its exploration programs for base and precious metals in central Somerset and northern Franklin Counties.

A number of other companies continued exploring for base and precious metals in Maine. Utah International Inc. continued its search for base and precious metals in the Him Pond area in northern Franklin County. The company conducted geomagnetic and geochemical surveys, along with some exploratory drilling.

The Penobscot Indian Nation's mining and minerals program completed the second year of evaluation of the mineral resources of the Penobscot and Passamaquoddy Indian Trust Lands, which comprised about 120,000 acres across the central part of the State.

Chevron Resources Co., having acquired Getty Mining Co.'s interests in Maine, including the Mount Chase lead, copper, zinc, silver, and gold deposits in northern Penobscot County, finalized its acquisition of the Bald Mountain mineral rights in Aroostook County.<sup>3</sup>

**Legislation and Government Programs.**—In January, the U.S. Department of Energy (DOE) announced the selection of two areas in Maine as potential sites for a deep-mined repository for disposal of high-level nuclear waste. These two areas, one in the Sebebago Batholith in the southwestern part of the State, the other in the Bottle Lake Complex northeast of Bangor, were among 12 sites in the Nation chosen for 3 to 4 years of detailed area characterization studies. Eventually, a single site is expected to be selected for the Nation's

second waste repository.

Following DOE's decision, the State passed legislation (Public Law, chapter 802 (2371)) in April that disapproved DOE's plan. DOE announced an indefinite postponement of all site-specific work associated with the second repository in late May, but reversed the decision in November in response to a suit filed by the western States, which are candidates for the first repository. DOE plans to resume its search for the second repository site in the summer of 1987; this search may include the crystalline rock sites chosen in Maine.

The Maine Geological Survey (MGS), a bureau of the Department of Conservation, continued participating with the U.S. Geological Survey (USGS) in a Cooperative Geologic Mapping Project, which included bedrock mapping in the eastern part of the State and detailed surficial mapping in the southwestern coastal zone. The MGS also continued updating and expanding the USGS Mineral Resource Data System, a computerized mineral data storage and analysis system. Other MGS activities included work on earthquake activity, landslides, hydrogeology, and marine geology programs.

During the year, the Maine Department of Environmental Protection granted several mining permits that would allow placer gold mining in streams in Franklin, Oxford, and Somerset Counties. The streams included Gold Brook in Franklin County and the Swift River, Sandy River, Nile Brook, and Gold Brook in Somerset County. The mining permit stated that activity must be confined to a sandy-gravelly-cobbly unvegetated streambed.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Maine was the only New England State that produced cement. Dragon Cement Co. produced both portland and masonry cement at a plant in Thomaston, Knox County. Strong demand for cement in the Northeast resulted in a 17% and 21% increase in output of portland and masonry cement, respectively. In addition, shipments of cement into Maine also increased in 1986 compared to those of 1985. Portland cement imported into the State rose 19%, while masonry cement shipments rose 20%. Most of the cement was utilized by ready-mixed concrete companies and concrete product

manufacturers.

**Clays.**—Morin Brick Co. mined common clay at operations in Androscoggin and Cumberland Counties, primarily for use in brick manufacture.

In January, New Gloucester town planners granted the city of Auburn permission to mine a 7-1/2-acre site within the city limits, which will supply 15,000 cubic yards of clay to be used as a liner for the city's ash landfill. The clay liner is expected to prevent leaching of incinerated ash from the city's steam generating plant, which processes trash from 26 surrounding communities.

**Garnet.**—Industrial Garnet Extractives

Inc. (IGE), near Rangeley, Oxford County, produced almandine garnet and a garnet-containing utility grit concentrate, which was used largely in sandblasting and water filtration. During the year, IGE completed improvements in processing facilities and changes in product line that significantly increased production capacity at the plant.

**Gem Stones.**—Semiprecious and gem quality mineral specimens continued to attract rockhounds and mineral specimen collectors to the State. Many fine specimens of amethyst, aquamarine, citrine, topaz, and tourmaline, to name a few, have been collected. Popular collecting localities include quarries in Androscoggin, Oxford, and Sagadahoc Counties.

**Peat.**—Humus peat was produced by Deer Hills Farms Inc. at a bog near Weeks Mill in Waldo County. All of the peat was sold in bulk form.

**Perlite (Expanded).**—Crude perlite shipped in from New Mexico was expanded by the Chemrock Corp. at a plant in Rockland, Knox County. The expanded perlite was sold locally, primarily as a filter aid.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Output of 8.6 million short tons of construction sand and gravel in 1986 was the highest reported in the last 7 years. In 1986, 99 companies operated 176 pits in the State. Leading counties in order of output were York, Cumberland, Aroostook, and Penobscot.

Table 4.—Maine: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate (including concrete sand) -----	702	\$2,935	\$4.18
Plaster and gunite sands -----	W	W	6.00
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	W	W	3.11
Asphaltic concrete aggregates and other bituminous mixtures -----	600	2,278	3.80
Road base and coverings <sup>1</sup> -----	1,297	2,357	1.82
Fill -----	790	2,090	2.65
Snow and ice control -----	549	1,037	1.89
Other -----	643	1,964	3.05
Other unspecified <sup>2</sup> -----	3,990	10,182	2.55
Total or average -----	3,852	22,843	2.66

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

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Output of crushed stone production increased nearly 10% in 1986, reflecting the continuing increased demand by the construction industry. Limestone, sandstone, traprock, and marl were quarried for cement manufacture, concrete aggregate, and railroad ballast.

During the year, Tilcon Inc., a leading

crushed stone producer in New England, opened its first Maine quarry in Wells. The quarry replaces the company's depleted sand and gravel resources in the same area and provides a new source of construction aggregate.

**Dimension.**—New England Stone Industries Inc. continued to quarry dimension granite at Crotch Island, Hancock County.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>State geologist and director, Maine Geological Survey, Augusta, ME.

<sup>3</sup>Foley, M. E. Annual Review 1986, Exploration 1986. Min. Eng., v. 39, No. 5, May 1987, p. 335.



Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Dragon Cement Co. <sup>1</sup> -----	Box 191 Thomaston, ME 04861	Quarry and plant --	Knox.
<b>Clays:</b>			
Morin Brick Co -----	Mosher Rd. Gorham, ME 04038	Pits and plants ---	Androscoggin and Cum- berland.
<b>Garnet:</b>			
Industrial Garnet Extractives Inc	Box 56A West Paris, ME 04289	Mill ----- Quarry -----	Oxford. Franklin.
<b>Perlite (expanded):</b>			
Grefco Inc -----	Box 177 Thomaston, ME 04861	Plant -----	Knox.
<b>Sand and gravel (construction):</b>			
Harry C. Crooker & Sons Inc ---	R.F.D. 4, Old Bath Rd. Brunswick, ME 04011	Pits and plants ---	Lincoln and Sagadahoc.
Dragon Products Co -----	Box 191 Thomaston, ME 04861	----do -----	Androscoggin, Franklin, Hancock, Somerset.
R. J. Grondin & Son -----	Rural Route 4, Box 65 Gorham, ME 04038	Pits -----	Cumberland and York.
Lane Construction Corp. <sup>1</sup> -----	Box 103 Bangor, ME 04401	----do -----	Aroostook, Penobscot, Waldo, Washington.
Madawaska Brick & Block Co --	R.D. 1, Box 250 Madawaska, ME 04765	Pit and plant -----	Aroostook.
Maine Department of Transporta- tion.	Augusta, ME 04333 ---	Pits and plants ---	Androscoggin, Aroostook, Cumber- land, Franklin, Knox, Lincoln, Oxford, Pe- nobscot, Piscataquis, Sagadahoc, Somerset, Waldo, York.
Portland Sand & Gravel Co. Inc --	Gray Rd. Cumberland, ME 04021	Pit and plant -----	Cumberland.
Tilcon Inc. <sup>1</sup> -----	Box 209 Fairfield, ME 04937	Pits and plants ---	Cumberland, Somerset, York.
White Bros. Inc -----	95 Warren Ave. Westbrook, ME 04092	Pit and plant -----	Cumberland.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
Blue Rock Industries -----	58 Main St. Westbrook, ME 04092	Quarries and mill --	Cumberland and Kenne- bec.
The Cook Concrete Co -----	960 Ocean Ave. Portland, ME 04103	Quarry and mill ---	Cumberland.
Dragon Products Co.-----	Box 191 Thomaston, ME 04861	Quarries -----	Knox.
Lane Construction Corp ---	Box 103 Bangor, ME 04401	----do -----	Aroostook and Penobscot.
<b>Dimension:</b>			
New England Stone Indus- tries Inc.	Providence Pike Smithfield, RI 02917	----do -----	Hancock.

<sup>1</sup>Also stone.

# The Mineral Industry of Maryland

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

By L. J. Prosser, Jr.<sup>1</sup>

The value of nonfuel mineral production in Maryland in 1986 was about \$313 million. Continued strong demand for raw materials used in construction resulted in a record-high value in 1986 and the fourth consecutive year in which value of mineral production increased.

Crushed stone production was at an all-

time high in Maryland in 1985 and again in 1986. Output of crushed stone accounted for about two-fifths of the State's total value of mineral production. Also, approximately 10% of Maryland's crushed stone production was used in manufacturing cement, the State's second leading commodity in terms of value.

Table 1.—Nonfuel mineral production in Maryland<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) - thousand short tons...	W	W	W	W	1,785	\$89,799
Clays <sup>2</sup> -----do-----	347	\$1,484	336	\$1,647	362	1,757
Gem stones-----do-----	NA	<sup>e</sup> 2	NA	<sup>e</sup> 2	NA	5
Lime-----thousand short tons...	7	419	10	608	10	546
Peat-----do-----	5	W	W	W	W	W
Sand and gravel (construction)-----do-----	14,234	46,671	<sup>e</sup> 17,000	<sup>e</sup> 58,000	18,173	86,925
Stone:						
Crushed-----do-----	<sup>e</sup> 22,100	<sup>e</sup> 94,000	24,406	98,584	<sup>e</sup> 26,400	<sup>e</sup> 126,000
Dimension-----do-----	<sup>r</sup> <sup>e</sup> 16	<sup>r</sup> <sup>e</sup> 1,065	18	1,218	<sup>e</sup> 21	<sup>e</sup> 1,286
Combined value of cement (masonry), clays (ball clay), sand and gravel (industrial), and values indicated by symbol W-----	XX	98,261	XX	98,215	XX	7,027
Total-----	XX	241,902	XX	258,274	XX	313,345

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not Available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes ball clay; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Maryland in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Allegany	Stone (crushed).
Baltimore	Stone (crushed), stone (dimension), clays.
Carroll	Cement, stone (crushed), clays.
Cecil	Stone (crushed).
Frederick	Cement, stone (crushed), clays, lime.
Garrett	Stone (crushed), peat, stone (dimension).
Harford	Stone (crushed), sand (industrial).
Howard	Stone (dimension).
Kent	Stone (dimension), clays.
Montgomery	Stone (crushed), stone (dimension).
Prince Georges	Clays.
Queen Annes	Stone (crushed).
Washington	Cement, stone (crushed), clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Maryland business activity

	1984 <sup>a</sup>	1985	1986 <sup>b</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	4,348	4,393	4,463
Total civilian labor force	do.	2,243	2,261	2,358
Unemployment	percent	5.4	4.6	4.5
<b>Employment (nonagricultural):</b>				
Mining total	thousands	1.7	1.7	1.6
Coal mining <sup>1</sup>	do.	.9	.8	.7
Manufacturing total	do.	219.4	217.2	209.8
Primary metal industries	do.	18.9	15.7	13.4
Stone, clay, and glass products	do.	7.3	7.0	6.1
Chemicals and allied products	do.	12.5	12.7	12.8
Petroleum and coal products <sup>1</sup>	do.	.8	.9	1.0
Construction	do.	116.0	128.8	138.8
Transportation and public utilities	do.	89.2	90.5	90.9
Wholesale and retail trade	do.	451.5	473.5	496.6
Finance, insurance, real estate	do.	103.8	109.7	117.4
Services	do.	444.5	472.8	503.5
Government and government enterprises	do.	387.9	393.6	392.2
Total	do.	1,814.0	1,887.8	1,950.8
<b>Personal income:</b>				
Total	millions	\$64,569	\$70,050	\$75,272
Per capita	do.	\$14,849	\$15,948	\$16,864
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do.	41.0	40.3	40.5
Total average hourly earnings, production workers	do.	\$9.5	\$9.7	\$10.0
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$332	\$318	\$364
Nonfarm	do.	\$41,418	\$45,257	\$49,022
Mining total	do.	\$135	\$176	\$174
Nonmetallic minerals except fuels	do.	\$18	\$19	\$17
Coal mining	do.	\$36	\$32	\$29
Manufacturing total	do.	\$5,895	\$6,126	\$6,145
Primary metal industries	do.	\$740	\$682	\$543
Stone, clay, and glass products	do.	\$204	\$211	\$201
Chemicals and allied products	do.	\$376	\$404	\$431
Petroleum and coal products	do.	\$28	\$30	\$33
Construction	do.	\$3,071	\$3,539	\$4,043
Transportation and public utilities	do.	\$2,686	\$2,857	\$2,998
Wholesale and retail trade	do.	\$7,237	\$7,932	\$8,636
Finance, insurance, real estate	do.	\$2,376	\$2,690	\$3,210
Services	do.	\$10,128	\$11,428	\$12,814
Government and government enterprises	do.	\$9,777	\$10,297	\$10,757

See footnotes at end of table.

Table 3.—Indicators of Maryland business activity —Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>3</sup> -----	38,551	42,137	42,378
Value of nonresidential construction <sup>3</sup> ----- millions_	\$1,473.9	\$1,873.6	\$1,825.7
Value of State road contract awards ----- do_	\$331.0	\$421.0	336.0
Shipments of portland and masonry cement to and within the State <sup>4</sup> ----- thousand short tons_	1,480	1,642	1,810
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions_	\$241.9	\$258.3	313.3
Value per capita -----	\$56	\$59	\$70

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—Attesting to the State's enhanced demand for minerals, Maryland in 1986 ranked 25th nationally in the value of mineral production compared with 34th in 1981. During the same period, Maryland increased its share of total U.S. mineral production value from 0.71% to 1.34%. Also in 1986, Maryland replaced Florida as the State with the highest value of mineral production per square mile.

The State's economy and construction industry continued to expand for the fourth consecutive year, paralleling gains in mineral production and value. The gains recorded in construction activity indicators (table 3) reflected the strong demand for industrial minerals by that industry. Additionally, employment in mining and construction contributed to the State's low unemployment rate of less than 5% or more than 2%

below the U.S. rate.

**Legislation and Government Programs.**—The Maryland Geological Survey (MGS) continued geologic and mineral-related studies at facilities in Baltimore. During the year, the MGS updated a 1983 directory of the State's mineral producers. More than 200 active mining operations will be included in the directory scheduled for publication in 1987.

In 1986, the U.S. Bureau of Mines closed its research center in Avondale, Prince Georges County. The Bureau had operated a research installation in Maryland since 1937. Ongoing research projects, including ones on characterization of ocean floor minerals, rapid scrap identification, and determination of silica particle-size distribution in respirable mine dust samples, were transferred to other Bureau facilities.

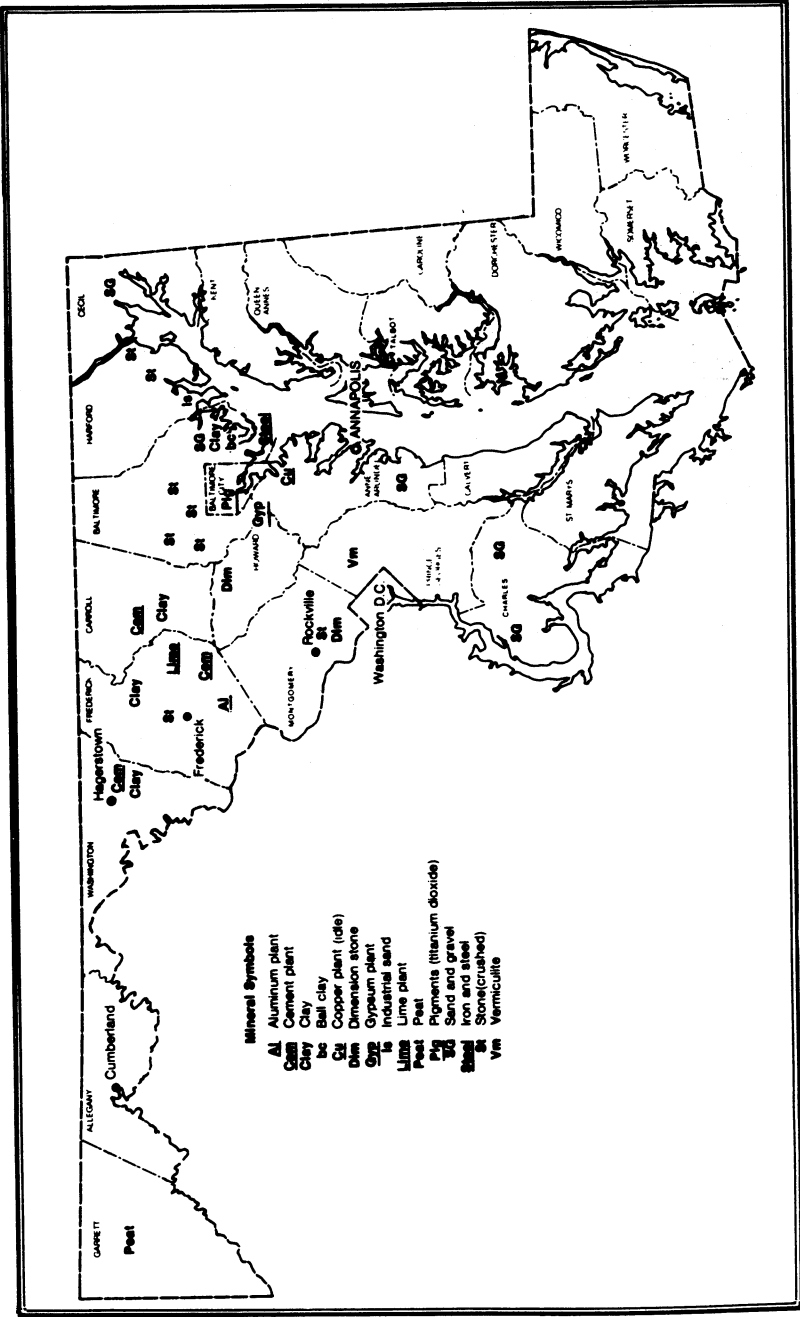


Figure 1.—Principal mineral producing localities in Maryland.

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

In addition to the commodities listed in table 1, the production and value of some processed or manufactured mineral commodities were also surveyed by the U.S. Bureau of Mines. Gypsum (byproduct and calcined), iron and steel slag, titanium dioxide pigments, and vermiculite (exfoliated) were shipped from domestic or foreign sources into Maryland. The companies processing these commodities and their locations are included in the principal producers table.

**Cement.**—Through acquisitions made last year, the State's four cement plants were 100% foreign owned. Nationally, about 49% of U.S. cement capacity was in foreign ownership. The Bureau of Mines identified that the most fundamental reason behind the growth in foreign investment in the U.S. mineral industries (particularly since 1981) has been that an increasing proportion of U.S. mineral firms and assets have been for sale, while foreign mineral companies have been the ones most willing and able to purchase these firms and/or their assets.<sup>2</sup>

Maryland's cement industry continued to operate at full capacity for the third consecutive year, reflecting continued demand from the construction industry. Parent companies and locations of the State's cement plants are listed in the "Principal producers" table.

**Clays.**—In Maryland, five companies produced common clay and shale, and one company mined ball clay. Brickmaking, lightweight aggregate, and cement manufacture were the uses for the common variety, and the ball clay was used primarily in ceramics, animal feed, and adhesives.

**Lime.**—The State's sole lime producer continued operations at Woodsboro in Frederick County.

**Peat.**—One company mined peat near Accident in Garrett County.

**Sand and Gravel.**—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Output of construction sand and gravel remained at record-high levels of about 17 million short tons in 1985 and 18.2 million tons in 1986. In the 10 years previous (1975-84), annual production averaged about 11.9 million tons. The State last reported output in excess of 16 million tons in 1965.

In 1986, sand and gravel was produced by 62 companies at 92 pits in 16 of Maryland's 23 counties. Prince Georges County led the State in output, followed by Anne Arundel and Charles Counties. Sand and gravel used for concrete aggregates accounted for more than one-half of the total sales.

Table 4.—Maryland: Construction sand and gravel sold or used by producers in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	9,536	\$49,491	\$5.19
Plaster and gunitite sands -----	W	W	7.67
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	621	2,601	4.19
Asphaltic concrete aggregates and other bituminous mixtures -----	588	2,048	3.48
Road base and coverings -----	1,326	4,691	3.54
Fill -----	716	2,025	2.83
Snow and ice control -----	W	W	5.85
Roofing granules -----	W	W	6.44
Other -----	128	622	4.86
Other unspecified <sup>1</sup> -----	5,259	25,447	4.84
Total or average -----	<sup>2</sup> 18,173	86,925	4.78

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—One company in Joppa, Harford County, marketed a specialty sand for water treatment applications and as a skid-resistant sand used in airport runway construction.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—The State's leading crushed stone producer, Genstar Stone Products Inc., at Hunt Valley, was sold for about \$318 million to Redland Aggregates Ltd., a United Kingdom building products group. The purchase included nine aggregate production sites in Maryland with estimated reserves of more than 1.5 billion short tons, or nearly 50% of the State's total aggregate reserves.<sup>3</sup> In 1985, another British firm, London & Northern America Inc., purchased Rockville Crushed Stone Inc., the State's third leading crushed stone producer. At the time of the purchase, the company was attempting to have a 530-acre tract rezoned to quarry stone for use as a skid-resistant roadbuilding material; however, the request was denied. Foreign investment in the State's stone industry was not expected to affect operations or production.

Since 1983, demand from the State's expanding economy and the resultant construction activity boosted crushed stone production by 37% or about 7 million tons. During that same span, U.S. output increased by nearly 20%.

With the increased mining activity, a reciprocal heightening of environmental concern related to noise, dust, and land use occurred. Local zoning ordinances, for example, prohibited mining or quarry expansions at sites in Boyds, Montgomery County; Boonsboro, Washington County; and Elk Mills, Cecil County. In each case, the rulings were appealed and remained pending

at yearend. Even if these rulings are overturned, the producers are faced with increased costs from the legal proceedings and from delays in production. In some instances, these costs are passed on to the consumer through higher roadbuilding costs. The price per ton of crushed stone in Maryland in 1986 was \$4.77 compared with \$4.16 nationally.

**Dimension.**—The State's dimension stone industry produced less than 1% of the U.S. total output. Granite gneiss and quartzite were quarried, mostly in Baltimore and Montgomery Counties.

## METALS

**Aluminum.**—One company continued producing aluminum at its smelter in Buckeystown, Frederick County. The United States produced about 3 million metric tons of primary aluminum in 1986, with Maryland ranking 11th among the 14 producing States. Individual company data are proprietary.

**Iron and Steel.**—Maryland's iron and steel industry was dominated by one producer, Bethlehem Steel Corp., at Sparrows Point. In January, the firm began producing continuous cast steel at the Baltimore County facility. The 2.9-million-short-ton-per-year caster cost about \$260 million, and more than 2 million tons of steel was produced in 1986. Bethlehem Steel produced about 13% of the Nation's steel in 1986, with about one-third of it made at Sparrows Point. It is anticipated that the caster will increase efficiency and lower the cost of production.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Sousa, L. J., E. H. Yaremchuk, and A. P. Graham. Foreign Direct Investment in the U.S. Minerals Industry. BuMines IC 9131, 1987, 24 pp.

<sup>3</sup>Industrial Minerals (London). Redland Buys Genstar Stone. Nov. 1986, No. 230, p. 19.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum:</b> Eastalco Aluminum Co. (Alumax Inc.).	5601 Manor Woods Rd. Frederick, MD 21701	Reduction plant	Frederick.
<b>Cement:</b> <b>Portland:</b> Coplax Cement Co., (Société des Ciments Français).	4120 Buckeystown Pike Lime Kiln, Box D Frederick, MD 21701	Quarry and plant.	Do.
<b>Portland and masonry:</b> Independent Cement Corp. (St. Lawrence Cement Inc.).	Box 650 Hagerstown, MD 21740	----do----	Washington.
Lehigh Portland Cement Co. (Heidelberger Zement AG).	Box L Union Bridge, MD 21791	----do----	Carroll.
<b>Slag:</b> Blue Circle-Atlantic <sup>1</sup> (Blue Circle Industries PLC).	Box 6687 Sparrows Point, MD 21219	Plant (slag cement).	Harford.
<b>Clays:</b> <b>Ball clay:</b> Cyprus Industrial Minerals Co., Cyprus Mines Corp.	9420 Pulaski Highway Baltimore, MD 21220 Box 188 White Marsh, MD 21162	Pit and plant --	Baltimore.
<b>Common clay and shale:</b> Baltimore Brick Co. (Merry Co.)	9801 Rocky Ridge Rd. Rocky Ridge, MD 21778	Pits and plants --	Baltimore and Frederick.
Maryland Clay Products Inc. (Borden Brick & Tile Co.).	7100 Muirkirk Rd. Beltsville, MD 20705	----do----	Frederick and Prince Georges.
Victor Cushwa & Sons Inc ----	Clearspring Rd. & Route 68N Box 160 Williamsport, MD 21795	Pit and plant --	Washington.
<b>Gypsum:</b> <b>Byproduct:</b> SCM Corp., SCM Pigments Div.	3901 Glidden Rd. Baltimore, MD 21226	Plant-----	Baltimore.
<b>Calcined:</b> National Gypsum Co., Gold Bond Building Products Div.	2301 South Newkirk St. Baltimore, MD 21224 500 Quarantine Rd. Box 3472 Baltimore, MD 21226	----do----	Do.
USG Corp -----		----do----	Do.
<b>Iron and steel:</b> Bethlehem Steel Corp ----- C. J. Langenfelder & Sons -----	Sparrows Point, MD 21219 ----- 8427 Pulaski Highway Baltimore, MD 21221	Mill (integrated) ----do----	Do. Do.
<b>Lime:</b> S. W. Barrick & Sons Inc -----	Woodsboro, MD 21798 -----	Quarry and plant.	Frederick.
<b>Peat:</b> Garrett County Peat Products ----	R.F.D. 1, Box 91 Accident, MD 21520	Bog and plant --	Garrett.
<b>Sand and gravel:</b> <b>Construction:</b> Charles County Sand & Gravel Co. Inc.	Waldorf Industrial Center Box 548 Waldorf, MD 20601 10 South River Club House Rd. Harwood, MD 20776	Pits and plant --	Anne Arundel, Charles, St. Marys.
Eastern Aggregates Inc.-----		Pits and plants --	Anne Arundel and Prince Georges.
Inland Materials Inc -----	4714 St. Barnabas Rd. Temple Hills, MD 20748 Box 273 Leonardtown, MD 20650	----do----	Prince Georges.
Maryland Rock Industries (Florida Rock Industries Inc.).		Pit and plant --	St. Marys.
York Building Products Co. Inc., Mason Dixon Sand & Gravel Div.	Pulaski Highway Perryville, MD 21403	----do----	Cecil.
<b>Industrial:</b> Harford Sands Inc -----	Box 25 40 Fort Hoyle Rd. Joppa, MD 21085	----do----	Harford.

See footnotes at end of table.



Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Stone:</b>			
<b>Crushed:</b>			
The Arundel Corp. <sup>2</sup> -----	110 West Rd. Baltimore, MD 21204	Quarries and plants.	Baltimore, Frederick, Harford.
Genstar Stone Products Inc. <sup>3</sup> -	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	-----do-----	Baltimore, Carroll, Frederick, Harford.
Maryland Materials Inc -----	Box W North East, MD 21901	Quarry and plant.	Cecil.
Rockville Crushed Stone Inc. --	Box 407 13900 Piney Meetinghouse Rd. Rockville, MD 20850	-----do-----	Montgomery.
<b>Dimension:</b>			
Patapsco Natural Stone Quarry Inc.	Marriottsville Rd. Marriottsville, MD 21104	-----do-----	Baltimore.
Stoneyhurst Quarries -----	Box 34463 8101 River Rd. Bethesda, MD 20817	-----do-----	Montgomery.
Weaver Stone Co -----	15027 Falls Rd. Butler, MD 21023	-----do-----	Baltimore.
<b>Titanium dioxide (pigments):</b>			
SCM Corp., SCM Pigments Div.	3901 Glidden Rd. Baltimore, MD 21226	Chemical plant.	Do.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co., Construction Products Div.	12340 Conway Rd. Beltsville, MD 20705	Plant.-----	Prince Georges.

<sup>1</sup>Also common clay and shale.<sup>2</sup>Also slag.<sup>3</sup>Also sand and gravel.

# The Mineral Industry of Massachusetts

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Commonwealth of Massachusetts, Executive Office of Environmental Affairs, for collecting information on all nonfuel minerals.

By Donald K. Harrison<sup>1</sup> and Joseph A. Sinnott<sup>2</sup>

The value of nonfuel mineral production in Massachusetts in 1986 was \$134.4 million, establishing a record-high value for the third consecutive year. Construction sand and gravel and crushed stone accounted for 82% of the value of mineral production.

Massachusetts ranked fifth nationally in dimension stone output. Since 1983, production increased more than 50%, primarily because of a greater demand for granite curbing, the State's dimension stone industry's primary end-use product.

Table 1.—Nonfuel mineral production in Massachusetts<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	240	\$1,212	265	\$1,388	140	\$871
Lime ----- do	171	12,426	159	10,935	W	W
Sand and gravel:						
Construction ----- do	14,168	42,139	<sup>e</sup> 14,900	<sup>e</sup> 47,500	19,200	60,464
Industrial ----- do	W	W	W	W	45	739
Stone:						
Crushed ----- do	<sup>g</sup> 8,400	<sup>e</sup> 39,000	9,354	42,881	<sup>e</sup> 10,000	<sup>e</sup> 50,000
Dimension ----- do	<sup>r</sup> <sup>e</sup> 64	<sup>r</sup> <sup>e</sup> 11,688	73	13,724	<sup>e</sup> 79	<sup>e</sup> 14,928
Combined value of gem stones, peat, and values indicated by symbol W	XX	898	XX	777	XX	7,395
Total -----	XX	<sup>r</sup> 107,363	XX	117,205	XX	134,397

<sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

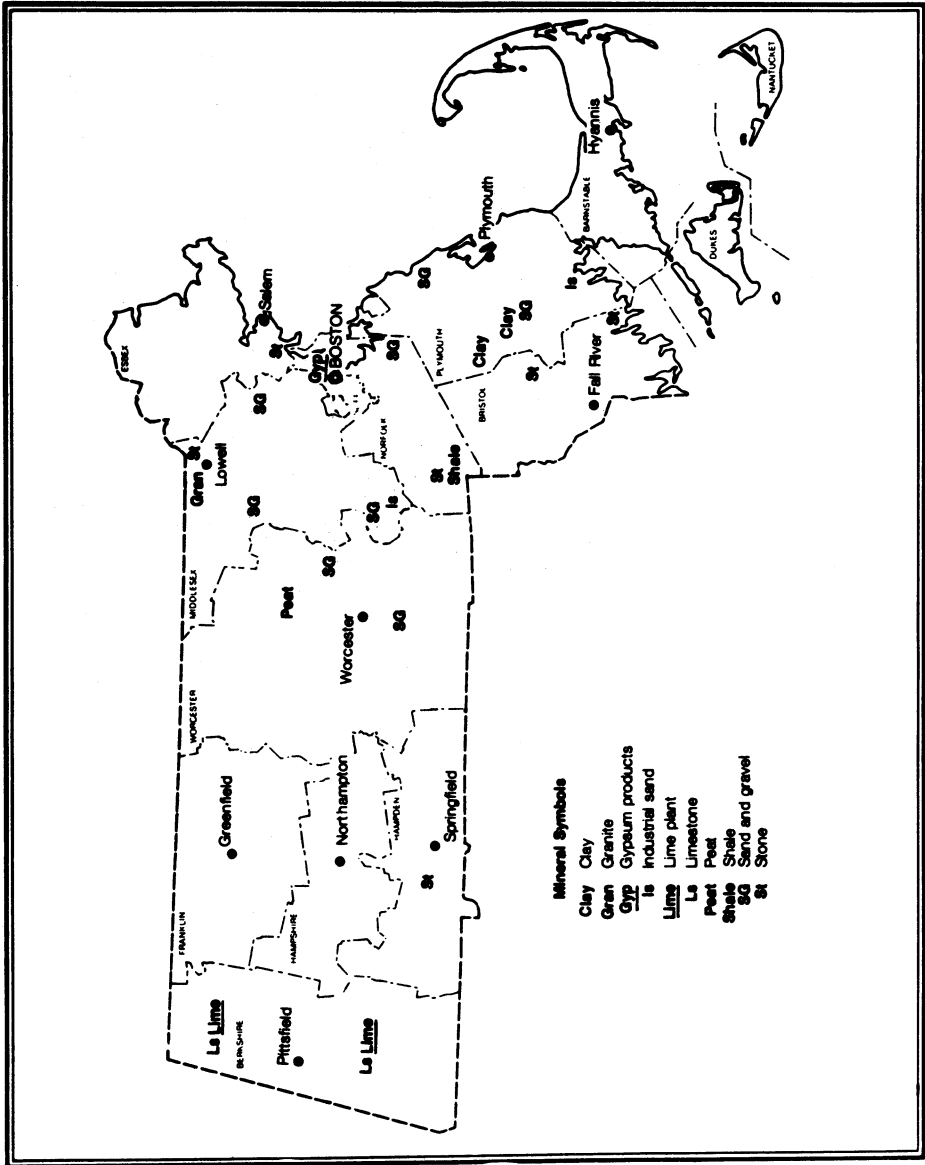


Figure 1.—Principal mineral-producing localities in Massachusetts.

Table 2.—Nonfuel mineral production in Massachusetts in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Berkshire	Lime, stone (crushed), stone (dimension).
Bristol	Stone (crushed).
Essex	Do.
Franklin	Do.
Hampden	Do.
Hampshire	Do.
Middlesex	Stone (dimension), stone (crushed), sand (industrial).
Norfolk	Stone (crushed), clays.
Plymouth	Clays, stone (crushed).
Suffolk	Stone (crushed).
Worcester	Stone (crushed), stone (dimension), peat.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Massachusetts business activity

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	5,792	5,819	5,832
Total civilian labor force	do	3,049	3,050	3,051
Unemployment	percent	4.8	3.9	3.8
<b>Employment (nonagricultural):</b>				
Mining total	thousands	1.2	1.5	1.8
Manufacturing total	do	672.0	654.3	618.6
Primary metal industries	do	16.5	15.8	15.8
Stone, clay, and glass products	do	11.8	11.5	10.8
Chemicals and allied products	do	17.8	17.6	17.3
Petroleum and coal products <sup>1</sup>	do	1.5	1.5	1.4
Construction	do	96.4	109.4	120.8
Transportation and public utilities	do	123.3	125.4	125.0
Wholesale and retail trade	do	656.4	681.4	703.1
Finance, insurance, real estate	do	179.0	188.1	203.4
Services	do	752.3	784.7	820.3
Government and government enterprises	do	371.4	381.3	387.8
Total <sup>2</sup>	do	2,851.8	2,926.0	2,980.7
<b>Personal income:</b>				
Total	millions	\$88,604	\$95,396	\$103,353
Per capita	do	\$15,298	\$16,393	\$17,722
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do	40.1	40.7	41.3
Total average hourly earnings, production workers	do	\$8.5	\$9.0	\$9.2
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$198	\$142	\$277
Nonfarm	do	\$64,432	\$70,501	\$76,813
Mining total	do	\$169	\$239	\$258
Manufacturing total	do	\$17,313	\$18,094	\$18,219
Primary metal industries	do	\$375	\$368	\$396
Stone, clay, and glass products	do	\$327	\$340	\$338
Chemicals and allied products	do	\$575	\$599	\$618
Construction	do	\$3,403	\$3,901	\$4,588
Transportation and public utilities	do	\$3,685	\$3,953	\$4,026
Wholesale and retail trade	do	\$10,348	\$11,472	\$12,707
Finance, insurance, real estate	do	\$4,316	\$4,900	\$5,940
Services	do	\$17,040	\$19,021	\$21,453
Government and government enterprises	do	\$7,904	\$8,596	\$9,294
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup>	do	29,288	39,196	45,215
Value of nonresidential construction <sup>4</sup>	millions	\$1,504.8	\$1,910.7	\$2,215.4
Value of State road contract awards <sup>5</sup>	do	\$228.6	\$230.0	\$573.4
Shipments of portland and masonry cement to and within the State <sup>6</sup>	thousand short tons	1,336	1,440	1,739

See footnotes at end of table.

Table 3.—Indicators of Massachusetts business activity—Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
Nonfuel mineral production value:			
Total crude mineral value ----- millions -----	\$107.4	\$117.2	\$134.4
Value per capita -----	\$19	\$20	\$23

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of the inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 25-26, 36-37.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

<sup>6</sup>Has no cement producing plants.

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 opening of new construction aggregate mining sites and the expansion of existing operations continued to be environmentally sensitive issues in the State. Restrictive zoning, increased land values, environmental regulations, and building on or near deposit sites limited or prevented resource development in many areas. Consequently, production was taking place farther and farther away from consumer markets. Because aggregates were a low-value, high-volume commodity, prices were dramatically affected by transportation distances. The costs of transporting aggregates, which can often exceed the sales price of the product at the processing plant, were invariably passed on to the consumer in the form of higher construction costs.

Reflecting an increased demand for cement by the building and construction industry of New England, construction was begun on a new cement terminal in the Port of Boston. A \$7 million cement storage, distribution, and packaging facility was being constructed by Coastal Cement Co. at the site of the former Boston Army Base. Coastal Cement, a newly formed company, was owned primarily by Cementos del Norte, a consortium of Spanish cement producers who planned to distribute the Spanish-produced cement throughout New England.

Emphasis on advanced materials research and development received wide-scale attention by the State's universities and corporations. Both the Massachusetts Institute of Technology (MIT), in Cambridge, and the University of Massachusetts at Amherst, conducted basic research on structural and electronic polymers, with emphasis on creating lightweight but strong heat-resistant materials and developing blends of polymers as a replacement for silicon in

electronic applications.

**Legislation and Government Programs.**—In January 1987, the U.S. Bureau of Mines published a report that analyzed the market, offshore resources, and the cost of mining sand and gravel near seven major coastline cities.<sup>3</sup> The report determined that significant deposits of sand and gravel exist off the coast of Boston and could be mined and processed competitively with land-based operations. Deposits 10 to 40 nautical miles off the coast would cost \$1.12 to \$2.93 per ton to mine. Capital costs would be about \$20 million to more than \$100 million, but, according to the report, when less expensive, foreign-built dredges are allowed to operate in U.S. waters, mining costs could be reduced by 50%. The study was undertaken because rapid growth and development created shortages of land-based sand and gravel in and around major urbanized areas.

In the case of the Boston area, however, the State has enacted several regulations that could affect offshore mining and processing operations. One such regulation, the Massachusetts Ocean Sanctuaries Act, would effectively prohibit sand and gravel production along 80% of the State's coast.

To encourage State support for basic research in the mineral sciences and engineering, the U.S. Bureau of Mines awarded an allotment grant of \$142,000 to MIT. The allotment was part of the mineral institute's program created by Public Law 98-409, the State Mining and Mineral Resources Research Institute Program Act. The act, signed into law in 1984, increased the required matching ratio from 1 State dollar to 1-1/2 State dollars for each Federal dollar in fiscal years 1985 and 1986. Thereafter, through expiration of the authority in 1989, matching must be on a 2:1 basis. An additional research grant was also made to

MIT for research in pyrometallurgy and respirable dust research projects.

The U.S. Geological Survey (USGS) continued its systematic marine sonar mapping of the offshore U.S. Exclusive Economic

Zone established in 1983. Also during the year, the USGS published two geologic maps covering two different areas in the State.<sup>4</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Abrasives (Manufactured).**—Norton Co., the world's largest manufacturer of abrasives, continued to produce nonmetallic crude abrasives at its plant in Worcester. The company manufactured bonded and coated abrasives primarily used in the surface conditioning, cutting, shaping, and finishing of many types of materials. Primary end users include foundries and steel mills, metal fabricators, glass and ceramic grinders, stonecutters, and the construction industry. During the year, the company established a new \$12 million advanced ceramics unit at Worcester. The new business unit was responsible for the identification and development of new ceramic technologies and products. The current focus included fine ceramic powders, bearings, heat exchangers, automotive components, and microporous ceramics.<sup>5</sup>

Washington Mills Abrasive Co., North Grafton, processed emery purchased from the John Leardi Emery Mine near Peekskill, NY. The emery was used as a nonslip additive for floors, pavements, and stair treads.

Dresser Industries Inc., General Abrasives Div., produced aluminum oxide and silicon carbide abrasives for the grinding wheel, coated abrasive, refractory, and metallurgical industries.

**Clays.**—In 1986, two companies produced clay in the State, one less than in 1985. The Plainville Corp., which produced lightweight shale for use in concrete block and structural concrete, ceased operations in 1986. As a result, 1986 production was about one-half of that of 1985. The two remaining producers, both located in Plymouth County, mined common clay for the manufacture of face brick.

**Graphite (Manufactured).**—Two companies, both in Lowell, Middlesex County, produced high-modulus graphite fiber used primarily by the aerospace industry.

**Gypsum (Calcined).**—Crude gypsum, shipped into the State from company-owned mines in other States and Canada, was calcined by USG Corp. at a plant in Suffolk County near Boston. The calcined gypsum was made into wallboard and shipped throughout New England primarily for use in residential construction.

**Lime.**—Two companies continued to manufacture lime in Berkshire County in the western part of the State from locally quarried limestone. Both output and value were lower in 1986 because of reduced demand from the agricultural, chemical, and construction industries. Markets for the lime included western New York and New England, with the majority shipped by truck.

**Peat.**—Reed-sedge peat was produced by Sterling Peat Co., Worcester County, in the north-central part of the State and was used primarily for agricultural purposes.

**Perlite (Expanded).**—Whittemore Products Inc. expanded processed perlite mined in New Mexico at its plant in Essex County. The expanded perlite was used in lightweight aggregate and as a horticultural medium.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for even-numbered years are based on annual company estimates.

The value of construction sand and gravel accounted for the largest portion (45%) of the State's total mineral value. In 1986, 119 companies mined construction sand and gravel from 130 operations in 13 counties. Leading counties in order of output were Worcester, Middlesex, Plymouth, and Hampden. Main uses for the material were for concrete aggregate, fill, and road base and coverings.

**Table 4.—Massachusetts: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thou- sands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,730	\$22,772	\$4.81
Plaster and gunite sands -----	119	836	7.03
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	160	831	5.19
Asphaltic concrete aggregates and other bituminous mixtures -----	755	3,392	4.49
Road base and coverings <sup>1</sup> -----	1,273	3,069	2.41
Fill -----	1,766	3,108	1.76
Snow and ice control -----	378	1,369	3.62
Railroad ballast -----	W	W	3.55
Other <sup>2</sup> -----	375	2,250	6.00
Other unspecified <sup>3</sup> -----	9,643	22,838	2.37
Total <sup>4</sup> or average -----	19,200	60,464	3.15

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

<sup>1</sup>Includes road and other stabilization (lime).

<sup>2</sup>Includes roofing granules and uses indicated by symbol W.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Two companies, one each in Middlesex and Plymouth Counties, produced industrial sand primarily for use in molding and core and in sandblasting.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains only estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone was the State's second leading mineral commodity accounting for 37% of the State's total value. Estimated production in 1986 amounted to 10 million short tons, an increase of 646,000 tons compared with that of 1985.

Production in 1986 represented the highest level of production in the State's history. Traprock (basalt) accounted for the majority of stone produced, followed by granite and limestone. Major uses were for road and concrete aggregate.

**Dimension.**—Massachusetts ranked fifth nationally in dimension stone output. Di-

mension granite, primarily sold for curbing, was mined in Berkshire, Middlesex, and Plymouth Counties. During 1986, H. E. Fletcher Co., the State's leading dimension stone producer, was sold and renamed Fletcher Granite Co. The firm owned quarries in Chelmsford and Milford.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. exfoliated imported vermiculite at its Easthampton plant in Hampshire County. Major uses were for insulation and fireproofing.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>State geologist, Executive Office of Environmental Affairs, Boston, MA.

<sup>3</sup>U.S. Bureau of Mines. An Economic Reconnaissance of Selected Sand and Gravel Deposits in the U.S. Exclusive Economic Zone. BuMines OFR 3-87, Jan. 1987, 113 pp.

<sup>4</sup>Oldale, R. N. 1986 Geologic Map of Nantucket and Nearby Islands, Massachusetts. U.S. Geol. Surv. Map I-1580, 1985, map scale 1:48,000.

Ratcliffe, N. M. Bedrock Geologic Map of the East Lee Quadrangle, Berkshire County, Massachusetts. U.S. Geol. Surv. Map GQ-1573, 1985, map scale 1:24,000.

<sup>5</sup>Norton Co. Securities and Exchange Commission Form 10-K, 1986, p. 3.

**Table 5.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
K-F Brick Co. Inc. -----	River St. Middleboro, MA 02346	Pit. -----	Plymouth.
Stiles & Hart Brick Co. -----	Box 367 Bridgewater, MA 02324	Pit. -----	Do.
<b>Graphite (synthetic):</b>			
Avco Corp -----	1275 King St., Box 9000 Greenwich, CT 06836	Plant -----	Middlesex.
The Stackpole Corp -----	Foundry Industrial Park Lowell, MA 01852	----do -----	Do.
<b>Gypsum (calcined):</b>			
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	----do -----	Suffolk.
<b>Lime:</b>			
Lee Lime Corp. <sup>1</sup> -----	Marble St. Lee, MA 01238	Plant and quarry.	Berkshire.
Pfizer Inc. <sup>1</sup> -----	260 Columbia St. Adams, MA 01220	----do -----	Do.

See footnotes at end of table.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat:			
Sterling Peat Co -----	Sterling Junction, MA 01565	Bog -----	Worcester.
Perlite (expanded):			
Whittemore Products Inc -----	Dundee Park Andover, MA 01810	Plant -----	Essex.
Sand and gravel:			
Construction:			
E. L. Dauphinais Inc -----	160 Worcester St., Box 488 North Grafton, MA 01536	Pits -----	Worcester.
Kimball Sand Co. Inc -----	Providence Rd., Box 29 Mendon, MA 01756	-----do -----	Do.
S. M. Lorusso & Sons Inc -----	331 West St. Walpole, MA 02081	-----do -----	Norfolk.
Rosenfeld Concrete Corp -----	Drawer E Milford, MA 01757	-----do -----	Worcester.
San-Vel Concrete Corp -----	Ayer Rd. Littleton, MA 01460	Pit -----	Middlesex.
Industrial:			
Holliston Sand Co. Inc -----	308 Lowland St., Box 97 Holliston, MA 01746	Pit -----	Do.
Whitehead Bros. Co. -----	Box 259, River Rd. Leesburg, NJ 08327	Pit -----	Plymouth.
Stone (1985):			
Crushed:			
John S. Lane & Son Inc -----	730 East Mountain Rd. Westfield, MA 01085	Quarries -----	Berkshire, Hampden, Hampshire.
S. M. Lorusso & Sons Inc -----	331 West St. Walpole, MA 02081	-----do -----	Middlesex, Norfolk, Suffolk.
Simeone Corp -----	1185 Turnpike St. Stoughton, MA 02072	-----do -----	Bristol and Norfolk.
Tilcon Inc -----	Box 114 72 South Main St. Acushnet, MA 02743	Quarry -----	Bristol.
Trimount Bituminous Products Co. -----	1935 Revere Beach Parkway Everett, MA 02149	Quarries -----	Essex.
Dimension:			
Fletcher Granite Co. -----	West Chelmsford, MA 01863	Quarry -----	Middlesex.
Williams Stone Co. Inc -----	Box 278 East Otis, MA 01029	-----do -----	Berkshire.
Vermiculite (exfoliated):			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Hampshire.

<sup>1</sup>Also stone.





# The Mineral Industry of Michigan

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

By James J. Hill<sup>1</sup>

Nonfuel mineral production in Michigan was valued at \$1.3 billion in 1986, nearly 10% below the mineral value reported in 1985. Lower levels of iron ore production and declining prices accounted for most of the State's loss in mineral value. Despite significant increases in copper, gold, and silver production, metallic minerals accounted for only 39% of the State's total

mineral value, after commanding a 43% share in 1985.

Leading industrial mineral commodities produced in the State, in order of value, were cement, calcium chloride, magnesium compounds, construction sand and gravel, crushed stone, and salt. Of these commodities, only cement and calcium chloride gained in value.

Table 1.—Nonfuel mineral production in Michigan<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons. . . . .	W	W	W	W	257	\$17,026
Portland ----- do. . . . .	W	W	W	W	4,713	216,120
Clays ----- do. . . . .	1,321	\$5,052	1,477	\$5,514	1,402	5,684
Gem stones ----- do. . . . .	NA	*15	NA	*15	NA	25
Gypsum ----- thousand short tons. . . . .	1,534	10,304	1,772	11,883	1,979	11,052
Iron ore (usable)						
----- thousand long tons, gross weight. . . . .	13,263	W	12,629	W	10,957	W
Lime ----- thousand short tons. . . . .	622	30,092	535	24,790	556	27,257
Peat ----- do. . . . .	227	4,341	282	5,414	298	6,170
Salt ----- do. . . . .	1,491	93,860	*927	*71,224	W	W
Sand and gravel:						
Construction ----- do. . . . .	36,071	76,540	*38,000	*93,000	42,514	91,886
Industrial ----- do. . . . .	3,400	33,060	3,345	25,469	3,343	29,493
Stone:						
Crushed ----- do. . . . .	*28,100	*92,000	30,685	95,953	*27,800	*83,900
Dimension ----- do. . . . .	*4	*113	4	113	*6	*148
Combined value of bromine, calcium chloride (natural), copper (1985-86), gold (1985-86), iodine (1984-85), iron oxide pigments (crude), magnesium compounds, silver (1985-86), and values indicated by symbol W	XX	1,063,214	XX	*1,053,672	XX	764,089
Total -----	XX	*1,408,591	XX	*1,387,047	XX	1,252,850

\*Estimated. <sup>1</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Michigan in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Allegan	Peat, stone (crushed).
Alpena	Cement, stone (crushed), clays.
Arenac	Stone (crushed).
Baraga	Do.
Bay	Cement, lime, stone (crushed).
Berrien	Sand (industrial).
Calhoun	Stone (crushed).
Cass	Do.
Charlevoix	Cement, stone (crushed).
Cheboygan	Stone (crushed).
Chippewa	Do.
Clinton	Peat, clays.
Delta	Stone (crushed).
Dickinson	Do.
Eaton	Stone (crushed), clays, peat.
Houghton	Stone (crushed).
Huron	Stone (crushed), lime.
Ingham	Peat.
Iosco	Gypsum.
Jackson	Stone (dimension).
Kent	Gypsum.
Lapeer	Calcium chloride, peat.
Mackinac	Stone (crushed).
Manistee	Magnesium compounds, salt, bromine.
Marquette	Iron ore, gold, stone (crushed), iron oxide pigments, silver.
Mason	Magnesium compounds, bromine, lime, sand (industrial).
Mecosta	Peat.
Midland	Calcium chloride, magnesium compounds, bromine, iodine.
Monroe	Cement, stone (crushed), clays, peat.
Muskegon	Sand (industrial).
Oakland	Peat.
Oceana	Sand (industrial).
Ontonagon	Copper, silver.
Ottawa	Sand (industrial).
Presque Isle	Stone (crushed), stone (dimension).
Saginaw	Lime.
St. Clair	Salt.
St. Joseph	Peat.
Sanilac	Peat, lime.
Schoolcraft	Stone (crushed), stone (dimension).
Shiawassee	Peat, clays.
Tuscola	Sand (industrial).
Wayne	Cement, lime, stone (crushed), sand (industrial), salt, clays.
Wexford	Sand (industrial).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Michigan business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	9,062	9,088	9,145
Total civilian labor force	do	4,347	4,355	4,398
Unemployment	percent	11.2	9.9	8.8
<b>Employment (nonagricultural):</b>				
Mining total	thousands	10.0	9.9	10.1
Metal mining <sup>1</sup>	do	2.6	2.3	2.8
Nonmetallic minerals except fuels <sup>1</sup>	do	2.7	2.7	2.8
Manufacturing total	do	962.8	1,002.4	998.3
Primary metal industries	do	53.6	52.0	49.6
Stone, clay, and glass products	do	17.3	17.4	16.9
Chemicals and allied products	do	40.7	41.0	40.7
Petroleum and coal products	do	2.3	2.5	2.3
Construction	do	92.7	107.8	115.3
Transportation and public utilities	do	140.2	145.9	147.8
Wholesale and retail trade	do	745.8	792.0	813.6
Finance, insurance, real estate	do	154.4	163.3	170.6
Services	do	708.0	759.5	786.9
Government and government enterprises	do	567.2	580.7	596.6
Total	do	2,381.0	3,561.5	3,639.2
<b>Personal income:</b>				
Total	millions	\$117,813	\$127,261	\$135,113
Per capita		\$13,001	\$14,003	\$14,775

See footnotes at end of table.

Table 3.—Indicators of Michigan business activity—Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	43.2	43.1	42.6	
Total average hourly earnings, production workers	\$12.2	\$12.6	\$12.8	
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$649	\$729	\$680
Nonfarm	do	\$84,872	\$93,195	\$99,656
Mining total	do	\$434	\$517	\$506
Metal mining	do	\$94	\$88	\$99
Nonmetallic minerals except fuels	do	\$74	\$75	\$69
Oil and gas extraction	do	\$266	\$354	\$327
Manufacturing total	do	\$33,374	\$36,909	\$38,096
Primary metal industries	do	\$1,921	\$1,874	\$1,925
Stone, clay, and glass products	do	\$528	\$566	\$581
Chemicals and allied products	do	\$1,430	\$1,545	\$1,643
Petroleum and coal products	do	\$92	\$97	\$130
Construction	do	\$3,318	\$3,914	\$4,454
Transportation and public utilities	do	\$4,748	\$4,996	\$5,230
Wholesale and retail trade	do	\$12,211	\$13,038	\$14,143
Finance, insurance, real estate	do	\$3,283	\$3,642	\$4,302
Services	do	\$15,750	\$17,829	\$19,548
Government and government enterprises	do	\$11,515	\$12,105	\$13,091
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup>	27,872	37,592	47,230	
Value of nonresidential construction <sup>4</sup>	millions	\$1,815.4	\$2,286.4	\$2,651.6
Value of State road contract awards <sup>5</sup>	do	\$221.5	\$501.0	\$380.7
Shipments of portland and masonry cement to and within the State	thousand short tons	1,993	2,207	2,605
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$1,408.6	\$1,387.0	\$1,252.9
Value per capita		\$155	\$153	\$137

<sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data do not add to total shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

In 1986, Michigan ranked fifth in the United States in value of nonfuel mineral production. The State led the Nation in sales of calcium chloride, crude iron oxide pigments, and magnesium compounds; ranked second for bromine, crude gypsum, peat, industrial sand, and steel slag; and was third for copper, pig iron, and construction sand and gravel.

**Employment.**—Michigan's average unemployment rate dropped from 9.9% in 1985 to 8.8% in 1986, according to statistics of the Michigan Employment Security Commission. In the Upper Peninsula, the unemployment rate fell from 15.1% in 1985 to 13.4% in 1986, the lowest it has been since 1981. Increased mining activity at Copper Range Co.'s White Pine copper mine and

Callahan Mining Corp.'s Ropes gold mine helped in part to alleviate the unemployment situation in the Upper Peninsula. Statewide, monthly employment in mining averaged 10,100 persons in 1986 compared with 9,900 persons in 1985. Monthly employment in mining in the Upper Peninsula averaged 3,200 persons in 1986 compared with 2,700 persons in 1985.

Several mineral industry contract disputes were reported by the Michigan Department of Labor during 1986. Work stoppages occurred at Michigan Silica Co.'s operations at Rockwood (42 workers, 34 days), St. Marys Peerless Cement Co. at Detroit (122 workers, 8 days), and American Aggregates Corp.'s Galesburg operations (9 workers, 24 days).

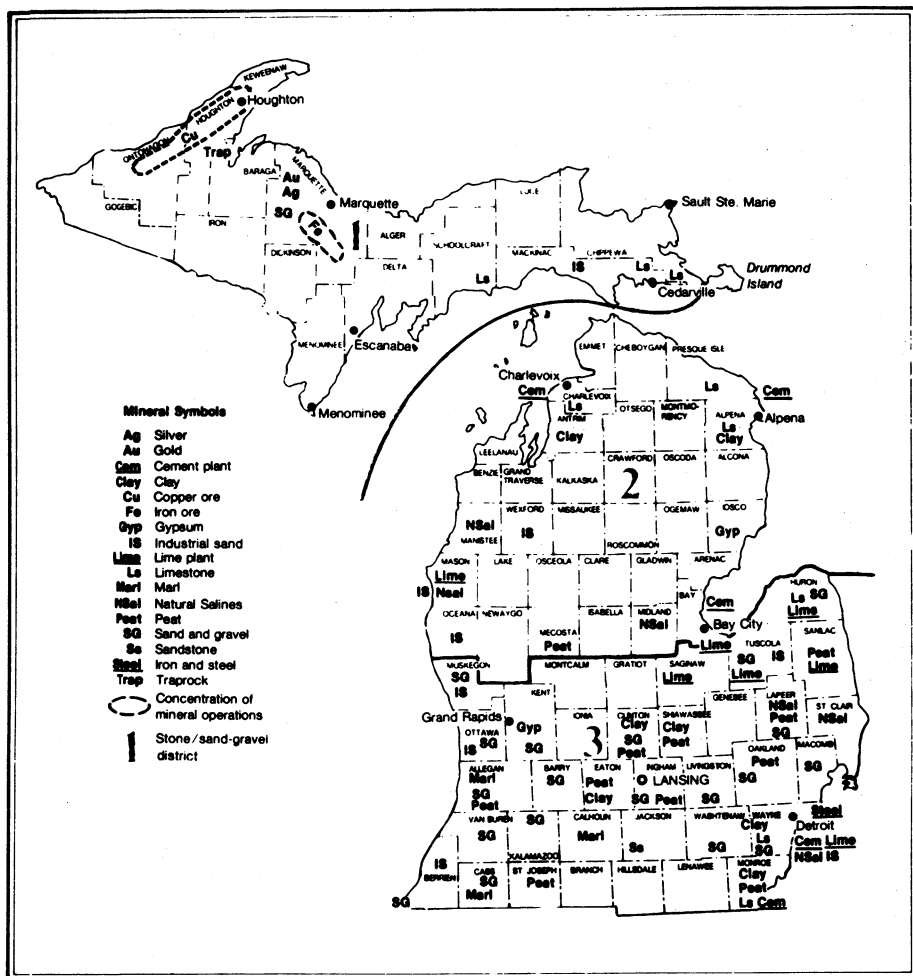


Figure 1.—Principal mineral-producing localities in Michigan.

**Exploration Activities.**—Michigan held its fourth metallic minerals lease sale on May 22, offering lease rights on 46,060 acres of State-owned mineral lands in six counties (Delta, Dickinson, Gogebic, Iron, Marquette, and Menominee). Six companies entered successful bids on 4,878 acres in five counties. Bids ranged from \$1.10 to \$41.50 per acre, with an average bid of \$7.81 per acre. The highest bid received was for a 476-acre tract in Norway Township, Dickinson County. Marquette County received the greatest amount of attention in the sale, with a total of 3,450 acres leased. A summary of the sale follows:<sup>2</sup>

	Successful bidder	Acres	Bonus bid
Amselco Exploration Inc		3,922	\$16,317
Callahan Mining Corp		160	1,202
Joseph Geldschlag		40	100
Kerr-McGee Corp		80	400
Jack Murphy		596	20,020
Resource Exploration Inc		80	88
Total		4,878	38,127

At yearend, the State had 41,959 acres of metallic mineral lands under lease, since establishing the leasing program in 1982. Total income realized by the State since 1982 was over \$1.3 million.

Michigan promulgated administrative rules for its nonmetallic minerals leasing program, which were certified by the attorney general's office in 1986. Lease terms included a \$1.00-per-acre minimum bid, 10-year primary term, a rental rate of \$3.00 per acre per year for the first 5 years and \$6.00 per acre per year for years 6 through 10, and a lease size of 40 acres. In October, the State held a nonmetallic minerals lease sale after being contacted by two parties interested in a nonmetallic minerals lease (limestone) on a 40-acre tract of land in Baraga County. The highest bid received was \$251.00 per acre.

Exploration activity in Michigan's Upper Peninsula focused on base and precious metals and diamonds. Eight companies drilled 70 exploration holes on State and private lands during the year. Total footage was about 61% more than the footage drilled in 1985. Dickinson County had the greatest amount of footage drilled, followed closely by Marquette County. Table 4 summarizes drilling activity for the past 3 years.

**Table 4.—Michigan: Metallic mineral exploration summary**

	1984	1985	1986
Number of companies -----	8	6	8
Total holes drilled -----	83	53	70
Total footage drilled -----	15,007	9,117	14,692

**Shipping.**—The commercial shipping season on the Great Lakes began on April 1 with the opening of the American locks at Sault Ste. Marie and ended 275 days later, on December 31. The U.S. Army Corps of Engineers reported 4,212 cargo carrier passages through the locks in 1986, down from

the 4,439 passages reported in 1985. Total tonnage for the season was 69.6 million short tons, 6% less than in the 1985 season. Table 5 provides a summary of mineral commodity traffic through the locks in 1985 and 1986.

**Table 5.—Michigan: Mineral products shipped through the Sault Ste. Marie locks**  
(Short tons)

Commodity	1985	1986
Cement -----	501,931	469,423
Coal -----	12,419,324	13,824,535
Iron ore -----	39,492,771	32,782,521
Iron and steel (manufactured), pig iron -----	269,719	317,995
Potash -----	1,907,846	1,573,846
Salt -----	283,024	261,265
Scrap (ferrous) -----	54,248	42,175
Stone <sup>1</sup> -----	1,699,014	1,631,101
Total -----	56,627,877	50,902,866

<sup>1</sup>Includes broken stone, gravel, and sand.

Source: U.S. Army Corps of Engineers, Detroit District.

The Lake Carriers' Association reported that 45.7 million long tons of iron ore moved across the Great Lakes during the 1986 shipping season, compared with 52.1 million tons of iron ore in 1985. About 31.2 million tons of iron ore was shipped from Lake Superior ports in 1986 and another 7.4 million tons from a Lake Michigan port. The rest of the iron ore shipments originated in eastern Canada.

Michigan iron ore was shipped from terminals at two ports—Chicago & Northwestern Transportation Co. Escanaba terminal on Lake Michigan and Lake Superior & Ishpeming Railroad Presque Isle terminal at Marquette on Lake Superior. Table 6 summarizes shipping activity at these ports.

**Table 6.—Michigan: Salient iron ore shipping statistics**

Year, port, and dock	Date of first shipment	Date of last shipment	Number of shipments	Total shipments (gross tons)	Average shipment (gross tons)	Largest shipment (gross tons)
<b>1985:</b>						
Marquette: LS&I Railroad -----	Apr. 3	Jan. 4 <sup>1</sup>	209	5,071,106	24,264	59,331
Escanaba: C&NW Transportation Co -	Mar. 28	Dec. 26	240	7,384,643	30,769	69,701
Total or average -----			449	12,455,749	27,741	69,701
<b>1986:</b>						
Marquette: LS&I Railroad -----	Apr. 18	Dec. 31	135	3,573,564	26,471	54,272
Escanaba: C&NW Transportation Co -	Mar. 24	Dec. 24	220	7,378,399	33,538	72,351
Total or average -----			355	10,951,963	30,851	72,351

<sup>1</sup>1986.

Source: Annual Reports of Lake Carriers' Association, 1985 and 1986.

The midyear lake freight rate from Marquette to lower lake ports was \$6.11 per long ton. Lake freight charges from Escanaba to Lake Michigan ports were \$4.45 per long ton and to Detroit and Lake Erie ports, \$5.64 per long ton. All rates remained the same as in 1985. These fees did not include loading, unloading, and dock charges.

On November 17, the President signed a \$16.3 billion water projects bill (Public Act 99-662), which authorized port, lock, dam, and flood protection construction nationwide. Among the projects authorized was a \$227.4 million proposal to build a second large lock at Sault Ste. Marie to function alongside the Poe Lock. The lock would provide for safer and more economical movement of cargo and would be capable of handling the large carriers now operating on the Great Lakes.

**Legislation and Government Programs.**—In May, Public Act 111 was enacted, which provided an additional \$83.6 million to the State's fiscal year 1986 budget. Among the line items contained in the bill was \$7.4 million in job-training funds, of which \$945,000 was slated for retraining workers at the White Pine copper mine in the Upper Peninsula.

Along with its regulatory functions in oil and gas, mineral wells, sand dune mining, and metallic and nonmetallic minerals leasing, the Michigan Geological Survey Division funded several mapping projects that focused on areas in the Upper Peninsula that may have potential for precious metals. During the year, an advisory group was appointed by the State geologist to review the existing geological functions of the survey and to make suggestions to improve and rebuild the geology program area. Their

report, due in 1987, will be used to guide the survey's geological studies in the future.

Several studies concerning Michigan mineral resources were conducted by researchers at Michigan Technological University (Michigan Tech) during 1986. One study at Michigan Tech's BioSource Institute involved in situ mining of copper sulfide ores (chalcocite) through bioleaching utilizing *Thiobacillus* bacteria. The bacteria are used to regenerate ferric iron that dissolves the chalcocite.

In a study funded by the Michigan Geological Survey Division, Michigan Tech researchers investigated graphite resources in northern Michigan. Preliminary geologic mapping and electromagnetic geophysical surveys were conducted in 1986. Drilling of the graphite-rich zones was planned for 1987. Studies were also made of a known manganese prospect near Copper Harbor, from which high-purity manganese was mined in the 1880's. Geological mapping and rock sampling were carried out in the fall of 1986. Geochemical and geophysical studies were to be performed in 1987.

The U.S. Bureau of Mines provided \$142,000 to the Mining and Mineral Resources Research Institute at Michigan Tech in fiscal year 1986. The funds are made available to research institutions under Public Law 98-409 to assist in the training of engineers and scientists in mineral-related disciplines.

Michigan received \$1,207,750 from the Federal Government for its share of funds generated by activities (timbering, mineral leasing, recreation, users fees, etc.) on national forest land in fiscal year 1986. The State received \$1,114,750 in fiscal year 1985.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Bromine.**—Michigan was one of two States producing bromine. The Dow Chemical Co. operated plants to extract bromine from well brines in Mason and Midland Counties, and Morton Thiokol Inc. operated a similar plant in Manistee County. Production was estimated to have declined nearly 86% during 1986, mainly because of the loss of production at Dow's Midland plant, which was closed in April. Major uses of bromine were for manufacturing chemicals, antiknock gasoline additives, fire retardants, and well-drilling and completion fluids.

**Calcium Chloride.**—Michigan continued to rank first of three States in calcium chloride production. Two companies extracted calcium compounds from well brines. Dow had operations in Mason and Midland Counties, and Wilkinson Chemical Corp. had an operation in Lapeer County. Production declined slightly during the year. Dow shut down its plant at Midland in April and concentrated its operations at Ludington where it had constructed a new calcium chloride flaking plant. Calcium chloride was used for concrete-set acceleration, dust control, oil and gas drilling, road-bed stabilization, road deicing, and other

miscellaneous uses.

**Cement.**—Nationally, Michigan ranked fourth and sixth, respectively, in sales of portland and masonry cement. Sales increased for both types of cement because of continuing improvements in construction demand. Five companies produced cement at four manufacturing plants (two wet and two dry-process) and one grinding facility. All plants produced Types I and II, general-use and moderate-heat portland cement. Other types produced at one or more plants were Type III, high-early-strength; portland-pozzolan; and waterproof portland. All except one company had sales of masonry cement. A total of 13 kilns were operated during 1986 to produce clinker, achieving 78% of the State's annual capacity. Finish grinding was utilized at about 72% of annual capacity.

**Table 7.—Michigan: Masonry cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	5	4
Production	W	270,865
Shipments from mills:		
Quantity	W	257,353
Value	W	\$17,026,159
Stocks at mills, Dec. 31	W	62,371

W Withheld to avoid disclosing company proprietary data.

**Table 8.—Michigan: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	5	5
Production	W	4,830,093
Shipments from mills:		
Quantity	W	4,712,704
Value	W	\$216,119,698
Stocks at mills, Dec. 31	W	467,745

W Withheld to avoid disclosing company proprietary data.

Raw materials consumed in cement manufacture included 6.2 million short tons of limestone and 1.2 million tons of clay and shale, as well as lesser quantities of fly ash, gypsum, iron ore, sand, and other material. The total of raw materials consumed was 8.3 million tons. Most portland cement sales were to ready-mixed concrete companies (75%), followed by concrete product manufacturers (13%), highway contractors (6%), building material dealers (4%), and other

(2%). Most of the cement was shipped to consumers by truck in bulk form. Shipments to and within Michigan included 2.5 million short tons of portland cement and 127,000 tons of masonry cement. This was an increase of 375,000 tons of portland and 23,000 tons of masonry cement, compared with 1985 figures.

Medusa Cement Co. initiated capital improvement projects in 1986 that, when completed in 1987 and 1988, will allow the Charlevoix plant to market an additional 300,000 tons of cement annually. The expenditures involved building new terminals and expanding another, plus adding a barge to increase the company's transportation capability.

Under terms of an agreement forged in 1985, National Gypsum Co. completed the sale of its Huron Cement Div. to Lafarge Corp. at yearend. Facilities included in the sale were the Alpena cement plant, 6 lake carriers, and 14 cement distribution terminals on the Great Lakes. National Gypsum had shut down the Alpena plant on December 14 and laid off 450 workers, stating it was exiting the cement business.

**Clays.**—Michigan ranked 10th of 44 States in the production of clays. Sales declined slightly during the year; however, average value per short ton increased \$0.32 to \$4.05, resulting in a slight increase in total value. Clay was produced by six companies in five counties. Alpena County led the State's production. Most of the State's clay production was utilized in cement manufacture; lesser quantities were used for making brick and flowerpots. Grand Ledge Clay Products Co., the State's last producer of clay tile, drain pipe, and flues, closed its doors in October and auctioned off its holdings because of depressed markets.

**Gem Stones.**—Michigan enjoys a brisk trade in mineral specimens and semiprecious gem stones during the tourist season. Value of specimens collected by rockhounds and dealers was estimated to be \$25,000 in 1986. Most common of the specimens collected were Lake Superior agates, native copper, and petoskey stones (a fossil coral). Several companies were exploring for diamonds, following the announcement of a kimberlite pipe discovery in 1981. No commercial finds were reported in 1986.

**Gypsum.**—Michigan ranked second of 20 States in the production of crude gypsum. Five companies operated mines in Iosco and Kent Counties; all but one company also operated calcining plants. Production of both crude and calcined gypsum increased



during 1986 because of continuing strong demand from the construction industry. Value of both crude and calcined gypsum declined because of competitive pressures in the marketplace. Gypsum was used mainly in wallboard manufacture, with lesser quantities used for agricultural purposes (soil conditioning), building plaster, and cement manufacture.

National Gypsum's Tawas Mine and USG Corp.'s Alabaster Mine, both in Iosco County, ranked second and third, respectively, in output among the 63 active gypsum mines in the United States in 1986.

**Lime.**—Michigan ranked ninth of 34 States in lime production. Production and value increased 4% and 10%, respectively, during 1986. Five companies produced quicklime in seven counties. Michigan Sugar Co. operated the greatest number of plants, in Huron, Saginaw, Sanilac, and Tuscola Counties. One company, Marblehead Lime Co., also produced hydrated lime. Detroit Lime Co., with operations at River Rouge, was the State's largest producer. Average value of lime increased \$2.69 per short ton to \$49.05 per ton. Lime was used in alkalies, steelmaking, sugar refining, and water treatment.

**Magnesium Compounds.**—Michigan continued to be the Nation's leading producer of magnesium compounds despite production and value declines of 22% and 24%, respectively. Some of the decline in production was attributable to the depressed state of the steel industry and its diminished need for refractory products. Three companies produced magnesium compounds from well brines in three counties. Dow had operations in Mason and Midland Counties, and Martin Marietta Corp., Magnesia Specialties Div., and Morton Thiokol had operations in Manistee County.

**Peat.**—Nationally, Michigan ranked second of 22 States in sales of peat. Sales and value of sales increased 6% and 14%, respectively, in 1986, surpassing the record high attained in 1985. Fourteen companies reported peat production in 11 counties. Sanilac County accounted for the greatest amount of peat mined in the State. Most of the State's peat, almost 219,000 short tons, was sold in packaged form. Sales were mainly for general soil improvement, which accounted for about 294,000 tons. Reed-sedge was the predominant type of peat mined.

Michigan Peat Co. expanded its Minden City operation during 1986 by purchasing six new harvesting machines and other

equipment at a cost of nearly \$300,000.

**Perlite (Expanded).**—Crude perlite obtained from mines in Western States was expanded at a plant in Vicksburg, Kalamazoo County, by Harborlite Corp. and at a plant in River Rouge, Wayne County, by USG. Sales increased about 11%, and value of sales increased about 18% during the year. Expanded perlite was used as a filler, as a filter aid, and for plaster aggregate.

**Potash.**—PPG Industries Inc. of Pittsburgh, PA, successfully completed testing its proprietary solution-mining technique at its \$5 million test facility in Hersey Township, Osceola County. A decision on whether the company would build a commercial extraction facility on the site was expected within a year.

**Salt.**—Michigan ranked 10th of 15 States in salt production after having ranked 8th (revised) in 1985. Sales and attendant value declined moderately in 1986. Part of the decline was attributed to Pennwalt Corp.'s closure of its chlorine and caustic soda plant at Wyandotte at yearend 1985. Other factors were the competitiveness within the salt industry and declining markets.

Salt was solution mined by two companies—Diamond Crystal Salt Co. had operations in Manistee and St. Clair Counties, and Morton Thiokol had an operation in Manistee County. Both companies produced evaporated salt with vacuum pans. Diamond Crystal also operated open pans at its St. Clair operation. Salt was sold in bulk form and as pressed blocks. Major uses were for food and chemical processing and as table salt.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Nationally, Michigan ranked third in production of sand and gravel for construction purposes. Output increased nearly 12% because of continuing improvements in demand from the construction industry. Value declined slightly during the year, mainly because larger quantities of sand and gravel were sold as lower valued fill material. Mining occurred in 73 of the State's 83 counties at 490 pits. Oakland County led the State's production, with output of 9.2 million short tons or 22% of the State's total production. Wayne County ranked second with 3.6 million tons of production.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 10 presents end-use data for construction sand and gravel produced in the Michigan districts depicted in figure 1.

American Aggregates lost its bid to have 824 acres of land in Highland Township, Oakland County, rezoned from agricultural to mining-extraction when the Michigan

Court of Appeals upheld a circuit judge's ruling that Highland Township rightly denied the rezoning petition. The Michigan Supreme Court refused to review American Aggregates' suit against the township, and the company filed a new motion asking the court to reconsider its refusal to review the lawsuit. A decision on this motion was pending at yearend.

**Table 9.—Michigan: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	5,114	\$16,784	\$3.28
Plaster and gunite sands -----	106	343	3.24
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	453	1,346	2.97
Asphaltic concrete aggregates and other bituminous mixtures -----	2,550	5,620	2.20
Road base and coverings <sup>1</sup> -----	8,013	16,427	2.05
Fill -----	2,278	3,298	1.45
Snow and ice control -----	493	792	1.61
Railroad ballast -----	56	93	1.66
Other -----	203	599	2.95
Other unspecified <sup>2</sup> -----	23,248	46,583	2.00
Total or average -----	42,514	<sup>3</sup> 91,886	2.16

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Table 10.—Michigan: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	328	1,900	855	1,941	4,490	14,632
Asphaltic concrete aggregates and other bituminous mixtures -----	319	720	698	1,548	1,533	3,353
Road base and coverings <sup>2</sup> -----	649	1,504	1,272	2,740	6,091	12,183
Fill -----	147	161	444	719	1,687	2,418
Snow and ice control -----	150	165	193	316	149	310
Railroad ballast -----	42	42	--	--	14	50
Other -----	--	--	2	5	201	594
Other unspecified <sup>3</sup> -----	1,016	1,435	1,467	2,475	20,764	42,674
Total <sup>4</sup> -----	2,651	5,928	4,932	9,744	34,930	76,214

<sup>1</sup>Includes concrete products (blocks, bricks, pipe, decorative, etc.) and plaster and gunite sands.

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Michigan ranked second nationally in industrial sand output, trailing Illinois by about 696,000 short tons. Sales dropped slightly during 1986, but value of sales increased nearly 16%. Average value per ton increased by \$1.21 to \$8.82. About 68% of the sales were for molding and core sand in foundries; other uses were for fiberglass manufacture, fillers, sand blasting,

traction, and miscellaneous. Industrial sand was produced by 7 companies from 14 pits in 10 counties. Ottawa County accounted for the greatest portion of the State's production. The leading producer in the State was Manley Bros. of Indiana Inc., with operations in Berrien and Van Buren Counties.

Ottawa Silica Co. of Ottawa, IL, which

mined industrial sand at a pit near Rockwood in Wayne County, was acquired during 1986 by United States Borax & Chemical Corp. of Los Angeles, CA, a subsidiary of The Rio Tinto Zinc Corp. PLC of the United Kingdom. The firm was renamed U.S. Silica Co. on January 1, 1987, after being merged with Pennsylvania Glass Sand Corp., which U.S. Borax purchased in 1985.

**Slag—Iron and Steel.**—Michigan continued to rank fourth nationally in sales of processed iron and steel slag. Edward C. Levy Co. processed slag in Wayne County from the steel mills of McLouth Steel Products Corp., the Great Lakes Steel Div. of National Steel Corp., and Rouge Steel Co., a subsidiary of Ford Motor Co. International Mill Service Co. processed slag from the North Star Steel Co. mill in Monroe County. Processed slag was sold for asphaltic concrete aggregates, concrete aggregates, lightweight concrete aggregates, road base and fill material, and other miscellaneous uses.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone sales and attendant value were estimated to have declined 9% and 13%, respectively, in 1986.

During the year, The France Stone Co. of Toledo, OH, was acquired by Koppers Co. Inc. of Pittsburgh, PA. France Stone operated a quarry in Monroe Township, Monroe County, and owned several other properties in the county.

Sales of metallurgical stone used in steel-making were sharply curtailed at USX Corp.'s Michigan Limestone Div.'s quarries as a result of the nationwide work stoppage at USS Inc.'s steel operations. About 40 of the 105 workers at the Cedarville operations were laid off because of changes in the quarrying and milling operations when the company resorted to selling its stone on the open market.

Near yearend, Inland Steel Mining Co. announced a \$17 million capital improvement program at its Minorca Mine on Minnesota's Mesabi Range, at the Empire Mine (in which it is a joint partner) on the Marquette Range, and at Inland Lime & Stone Co.'s Gulliver operations. The taconite plants were to be converted to the production of fluxed pellets, with the limestone to be shipped from the Gulliver quarry. Improvements at the quarry were to include enlarging the boat-loading facility

and adding a new line at the sizing plant to produce stone sizes needed for making fluxed pellets.

**Dimension.**—Sales and value of sales of dimension stone were estimated to have increased 40% and 31%, respectively, during 1986.

**Sulfur (Recovered).**—Elemental sulfur was recovered as a byproduct at oil refining operations of Marathon Oil Co. at Detroit in Wayne County and Shell Western E&P Inc. at Manistee in Manistee County. Sales and value of sales declined 12% and 22%, respectively, during 1986. Average value dropped \$12.22 per metric ton. Most of the sulfur sold was used in the manufacture of sulfuric acid.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. continued to exfoliate crude vermiculite shipped to its plant in Wayne County from mines in the Western States. Sales declined about 18% during the year, but average value per short ton increased substantially. Vermiculite was used for agricultural purposes, block insulation, fireproofing, loose-fill insulation, and concrete and plaster aggregates.

## METALS

**Abrasives (Manufactured).**—Michigan was the leading producer of steel shot and grit and was one of two States producing cut-wire shot. Steel shot and grit was manufactured by Abrasive Materials Inc. at Hillsdale in Hillsdale County, Ervin Industries Inc. at Adrian in Lenawee County, and Metaltec Steel Abrasives Co. at Canton in Wayne County. Abrasive Materials also produced cut-wire shot. Production and sales increased for both commodities during 1986. Average value dropped \$23.97 per short ton for steel shot and grit. Manufactured abrasives were used primarily by the automobile, foundry, and steel industries.

**Copper, Gold, and Silver.**—Nationally, Michigan ranked 3d in copper sales, 10th in gold, and 8th in silver. Two mines accounted for the State's production. Copper Range's White Pine Mine in Ontonagon County produced copper and silver, and Callahan Mining's Ropes Mine in Marquette County produced gold and silver.

The White Pine refinery, which was closed in 1984, restarted operations in May, with the first copper cathodes shipped in late June. November marked the first anniversary of the mine's reopening. By yearend, mine production was over 350,000 short tons of ore monthly, and copper was refined at a rate of over 10 million pounds per

month. Employment at the end of December totaled 912 persons.

The Ropes Mine experienced startup difficulties in the first half of the year with excessive ore dilution and low mill recoveries. Changes in the mining method and modifications to the mill resolved these problems. A new shaft that increased the mine's efficiency was completed in November. Exploration for new reserves continued in 1986, with nine holes drilled on acreage Callahan Mining leased in 1985.

**Iron Ore.**—Michigan ranked second in iron ore shipments, following Minnesota, and accounted for 27% of the national output of usable ore in 1986. All production was from the Empire and Tilden Mines, managed and partially owned by Cleveland-Cliffs Iron Co., on the Marquette Range. Shipments of taconite pellets to the steel industry declined for the second consecutive year, falling 13% below 1985 figures. Foreign steel imports and the resultant contraction of the U.S. steel industry accounted for this decline. The Empire and Tilden

Mines operated at 89% and 44% of capacity, producing 7.1 million long tons and 3.5 million tons, respectively. As in prior years, layoffs occurred at both mines so inventories could be adjusted to meet steel company partners' demands for pellets. The Tilden Mine was inactive from August through most of November.

In November, Inland Steel Co. announced a \$17 million project to switch to fluxed pellets for feed for its Indiana steel mill. The project involved converting its share of production at the Empire Mine (40%), along with that of its wholly owned Minorca Mine in Minnesota, to production of the limestone-enhanced pellets. Limestone was expected to be supplied by Inland Lime & Stone Co.'s quarry at Gulliver, which was slated to renovate shipping and sizing facilities.

Cleveland-Cliffs acquired Pickands Mather & Co. in late December. Pickands Mather managed and had equity interests in iron ore and coal mines in Australia, Canada, and the United States.

**Table 11.—Michigan: Usable iron ore<sup>1</sup> produced (direct shipping and all forms of concentrates), by range**

(Thousand long tons, gross weight, unless otherwise specified)

Year	Marquette Range	Menominee Range (Michigan part)	Gogebic Range (Michigan part)	Total		
				Gross weight		Iron content (percent)
				Ore	Iron content	
1854-1981	523,114	<sup>2</sup> 316,232	<sup>3</sup> 249,625	1,088,971	NA	NA
1982	6,874	--	--	6,874	4,426	64.4
1983	9,339	--	--	9,339	6,024	64.5
1984	12,982	--	--	12,982	8,374	64.5
1985	12,479	--	--	12,479	8,052	64.5
1986	10,558	--	--	10,558	6,802	64.4
Total	575,346	<sup>4</sup> 316,232	<sup>4</sup> 249,625	1,141,203	NA	NA

NA Not available.

<sup>1</sup>Exclusive after 1905 of iron ore containing 5% or more manganese.

<sup>2</sup>No production after 1981.

<sup>3</sup>No production after 1979.

<sup>4</sup>Distribution by range partly estimated before 1906.

**Iron Oxide Pigments.**—Michigan ranked first of four States in shipments of crude iron oxide pigments. All of the crude hematite material was shipped from stockpile at Cleveland-Cliffs' Mather Mine in Marquette County. Finished iron oxide pigments were manufactured by BASF Corp., Chemicals Div., Dyestuffs & Pigments Group at a plant in Wyandotte, Wayne County. Major uses were for paint and coatings, inks, and plastics.

**Iron and Steel.**—According to the American Iron and Steel Institute, Michigan rank-

ed fourth in raw steel output, producing 7.5 million short tons in 1986, about 2% over 1985 figures. Pig iron production was 4.7 million tons, 100,000 tons less than in 1985.

The State's steel industry continued its cost-cutting efforts and investment in new technology to battle foreign steel imports. McLouth Steel Products, which completed a multimillion-dollar capital improvement program at its plants in Gibraltar and Trenton in 1985, received wage concessions from its workers at midyear. The new contract agreement, effective through mid-

November 1988, allowed the company to offer early retirement to 250 of its 1,800 union workers by combining and eliminating some jobs. The remaining workers received wage increases, incentive pay, a dental plan, and higher pay classification for combined jobs in return for a freeze on cost-of-living allowances. At yearend, the company was in dire financial straits and seeking ways to restructure.

National Steel's Great Lakes Steel Div. dedicated a new, 72-inch-wide electrogalvanizing line at its mill in Ecorse that will provide corrosion-resistant steel to the automobile industry. Construction continued on a second continuous caster, ladle metallurgy station, and other facilities that were scheduled for startup in the third quarter

of 1987.

Union workers at the Rouge Steel mill in Dearborn agreed to a 60-day extension to their contract, averting a strike on August 1. The agreement was extended on a day-to-day basis to yearend. Double Eagle Steel Coating Co. began operations in March. This venture, jointly owned by Rouge Steel and USX, produced one- and two-sided electrogalvanized coated sheet steel for the automobile industry. The new facility had production capability of 700,000 short tons per year.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Michigan Department of Natural Resources. Metallic Minerals Lease Sale Summary. May 22, 1986.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives (manufactured):</b>			
Abrasive Materials Inc -----	Box 291 Hillsdale, MI 49242	Plant-----	Hillsdale.
Ervin Industries Inc -----	Box 1168 Ann Arbor, MI 48106	----do-----	Lenawee.
Metaltec Steel Abrasives Co -----	41155 Joy Rd. Canton, MI 48187	----do-----	Wayne.
<b>Cement:</b>			
Aetna Cement Corp., a subsidiary of Lake Ontario Cement Ltd.	Box 80 Essexville, MI 48732	Grinding plant -----	Bay.
Dundee Cement Co., a division of Holderbank Financiere Glaris SA. <sup>1 2</sup>	Box 122 Dundee, MI 48131	Quarry, clay pit, plant	Monroe.
Medusa Cement Co., Medusa Corp., a subsidiary of Crane Co. <sup>1 2</sup>	Box 5668 Cleveland, OH 44101	----do-----	Charlevoix.
National Gypsum Co., Huron Cement Div. <sup>2</sup>	4000 Town Center Suite 2000 Southfield, MI 48075	----do-----	Alpena.
St. Marys Peerless Cement Co., a division of St. Marys Cement Ltd.	9333 Dearborn St. Detroit, MI 48209	Plant-----	Wayne.
<b>Clays:</b>			
F. W. Ritter Sons Co -----	12670 North Dixie Hwy. South Rockwood, MI 48179	Clay pit and plant ---	Monroe.
Charles J. Rogers Inc -----	Box 3080 Melvindale, MI 48122	Clay pit -----	Wayne.
U.S. Brick Co., Michigan Div., a subsidiary of Canada Brick Co.	3820 Serr Rd. Corunna, MI 48817	Clay pit and plant ---	Shiawassee.
<b>Copper:</b>			
Copper Range Co. <sup>3</sup> -----	Box 100 White Pine, MI 49971	Underground mine, concentrator, smelter, refinery.	Ontonagon.
<b>Gold:</b>			
Callahan Mining Corp. <sup>3</sup> -----	6245 North 24th St. Phoenix, AZ 85016	Underground mine and plant.	Marquette.
<b>Gypsum:</b>			
Domtar Industries Inc -----	Box 1670 Grand Rapids, MI 49501	----do-----	Kent.
Georgia-Pacific Corp -----	133 Peachtree St., NE. Atlanta, GA 30303	----do-----	Do.
Michigan Gypsum Co -----	Box 6280 Saginaw, MI 48608	Open pit mine -----	Iosco.
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	Open pit mine and plant.	Do.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	Open pit mine ----- Plant-----	Do. Wayne.
<b>Iron ore:</b>			
Cleveland-Cliffs Iron Co. <sup>4</sup> -----	504 Spruce St. Ishpeming, MI 49849	Open pit mines and plants.	Marquette.
<b>Iron oxide pigments (finished):</b>			
BASF Corp., Chemicals Div., Dyestuffs & Pigments Group.	491 Columbia Ave. Holland, MI 49423	Plant-----	Wayne.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Iron and steel:</b>			
McLouth Steel Products Corp -----	1650 West Jefferson Trenton, MI 48183	Plant -----	Wayne.
National Steel Corp., Great Lakes Steel Div.	1 Quality Dr. Ecorse, MI 48229	-----do-----	Do.
Rouge Steel Co., a subsidiary of Ford Motor Co.	3001 Miller Rd. Dearborn, MI 48121	-----do-----	Do.
<b>Lime:</b>			
Detroit Lime Co., a subsidiary of Edward C. Levy Co.	9300 Dix Ave. Dearborn, MI 48120	-----do-----	Do.
The Dow Chemical Co., Ludington Div	2020 Dow Center Midland, MI 48640	-----do-----	Mason.
Marblehead Lime Co., a division of General Dynamics Corp.	222 North LaSalle St. Chicago, IL 60601	Plants -----	Wayne.
Michigan Sugar Co.-----	Box 1348 Saginaw, MI 48605	-----do-----	Huron, Sagi- naw, Sani- lac, Tus- cola.
<b>Peat:</b>			
Al-Par Peat Co -----	9551 Krouse Ovid, MI 48866	Bog and plant -----	Shiawassee.
Balzer Peat Products Inc -----	9698 Coleman Rd. Haslett, MI 48840	-----do-----	Clinton.
Fletcher & Rickard -----	25800 Haas Rd. New Hudson, MI 48165	-----do-----	Oakland.
Hyponex Corp.-----	2013 South Anthony Blvd. Fort Wayne, IN 46803	Bogs and plants -----	Lapeer and Shiawassee.
Michigan Peat Co -----	Box 6383 Houston, TX 77266	-----do-----	Sanilac.
<b>Perlite (expanded):</b>			
Harborlite Corp.-----	Box 458 Escondido, CA 92025	Plant -----	Kalamazoo.
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	-----do-----	Wayne.
<b>Salines (natural):<sup>5</sup></b>			
The Dow Chemical Co -----	2020 Dow Center Midland, MI 48640	Brine wells and plants	Mason and Midland.
Martin Marietta Corp., Magnesia Specialties Div.	Executive Plaza II Hunt Valley, MD 21030	Brine wells and plant	Manistee.
Morton Thiokol Inc -----	110 North Wacker Dr. Chicago, IL 60606	-----do-----	Do.
<b>Salt:</b>			
Diamond Crystal Salt Co -----	916 South Riverside St. Clair, MI 48079	Brine wells and plants	Manistee and St. Clair.
Morton Salt Co., a division of Morton Thiokol Inc.	110 North Wacker Dr. Chicago, IL 60606	Brine wells and plant	Manistee.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
American Aggregates Corp -----	Drawer 160 Greenville, OH 45331	Pits and plants -----	Kalamazoo, Livingston, Macomb, Oakland.
Blount Materials Corp -----	Box 1468 Saginaw, MI 48605	-----do-----	Oakland and Osceola.
Holloway Sand & Gravel Co. Inc -----	29250 Wixom Rd. Wixom, MI 48096	-----do-----	Lapeer, Oak- land, Wash- tenaw.
Edward C. Levy Co.:			
Lyon Sand & Gravel Co.-----	4780 South Hill New Hudson, MI 48165	-----do-----	Oakland.
Milford Sand & Gravel Co.-----	-----do-----	-----do-----	Do.
Natural Aggregates Corp -----	65545 Mound Rd. Romeo, MI 48065	-----do-----	Livingston and Ma- comb.
Portable Aggregates Producers Inc.	1401 Souter Blvd. Troy, MI 48084	-----do-----	Livingston and Oakland.
Bill Smith Sand & Gravel -----	Box 23 Otsego, MI 49078	-----do-----	Allegan.
Thomson Sand & Gravel Inc -----	48399 West Seven Mile Rd. Northville, MI 48167	Pit and plant -----	Wayne.
Whittaker & Gooding Co.-----	5800 Cherry Hill Rd. Ypsilanti, MI 48197	Pits and plants -----	Lapeer and Washte- naw.
<b>Industrial:</b>			
Construction Aggregates Corp -----	Box 68 Ferrysburg, MI 49409	-----do-----	Ottawa.
Manley Bros. of Indiana Inc.-----	Box 538 Chesterton, IN 46304	-----do-----	Berrien and Van Buren.
Nugent Sand Co. Inc -----	Box 1209 Muskegon, MI 49443	-----do-----	Muskegon.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel —Continued</b>			
<b>Industrial —Continued</b>			
Sand Products Corp -----	1938 First National Bldg. Detroit, MI 48226	Pits and plants -----	Mackinac and Oceana.
Sargent Sand Co -----	Box 6280 Saginaw, MI 48603	----_do-----	Mason, Tus- cola, Wex- ford.
U.S. Silica Co -----	20837 North Huron River Dr. Rockwood, MI 48173	Pit and plant -----	Wayne.
<b>Slag—iron and steel:</b>			
International Mill Service Co -----	1818 Market St. Philadelphia, PA 19103	Plant -----	Monroe.
Edward C. Levy Co -----	8800 Dix Ave. Detroit, MI 48209	Plants -----	Wayne.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
<b>Limestone:</b>			
Drummond Dolomite Inc., a division of Bethlehem Steel Corp.	Martin Tower Bethlehem, PA 18016	Quarry and plant ---	Chippewa.
Inland Lime & Stone Co., a division of Inland Steel Co. Presque Isle Corp -----	Gulliver, MI 49840 -----	Quarries and plants --	Mackinac and Schoolcraft.
Rockwood Stone Co. Inc ---	Box 426 Alpena, MI 49707	Quarry and plant ---	Presque Isle.
USX Corp., Michigan Lime- stone Div.	Box 113 Rockwood, MI 48173 Rogers City, MI 49779 -----	Quarries and plants -- ----_do-----	Monroe and Wayne. Mackinac and Presque Isle.
<b>Marl:</b>			
Poehlman & Son -----	Route 2 Cassopolis, MI 49031	Pit -----	Cass.
<b>Traprock:</b>			
Houghton County Road Commission.	Box 269 Hancock, MI 49930	Quarries and plant --	Houghton.
<b>Dimension:</b>			
<b>Limestone:</b>			
Inwood Stone Products Co --	Box 24 Cooks, MI 49817	Quarry -----	Schoolcraft.
Onaway Stone Co -----	715 Three Mile Rd. Traverse City, MI 49684	----_do-----	Presque Isle.
<b>Sandstone:</b>			
Jude Stone Quarry Co ----	338 Austin Rd. Napoleon, MI 49261	----_do-----	Jackson.
<b>Sulfur (recovered):</b>			
Marathon Oil Co -----	1300 South Fort St. Detroit, MI 48217	Elemental sulfur re- covered as a byprod- uct of oil refining.	Wayne.
Shell Western E&P Inc -----	Box 1523 Houston, TX 77251	----_do-----	Manistee.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Processing plant ----	Wayne.

<sup>1</sup>Also clays.<sup>2</sup>Also crushed limestone.<sup>3</sup>Also silver.<sup>4</sup>Also iron oxide pigments.<sup>5</sup>Includes bromine, calcium chloride, iodine, and magnesium compounds.

# The Mineral Industry of Minnesota

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

By James J. Hill<sup>1</sup>

Nonfuel mineral production in Minnesota was valued at \$1.1 billion, down about \$420 million when compared with the 1985 figure. Value of iron ore shipments alone fell \$413 million, as shipments reached their lowest level since the recession of 1982. Major factors affecting iron ore sales were the closure of the Reserve Mining Co.'s operations at Babbitt and Silver Bay and a work stoppage at USX Corp.'s Minntac

operations at Mountain Iron in the latter half of the year. Sales also declined during the year for peat, sand and gravel, and dimension stone.

Nationally, Minnesota ranked sixth in nonfuel mineral production after ranking fifth in 1985. The State was the leading producer of iron ore and ranked sixth in sales of peat.

Table 1.—Nonfuel mineral production in Minnesota<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones.....	NA	<sup>e</sup> \$5	NA	<sup>e</sup> \$5	NA	\$5
Iron ore (usable)						
thousand long tons, gross weight...	35,602	1,561,516	34,977	1,430,353	28,779	1,017,261
Manganiferous ore..... short tons...	68,019	W			W	W
Peat..... thousand short tons...	24	W	34	1,720	W	W
Sand and gravel:						
Construction..... do.....	22,612	49,087	<sup>e</sup> 25,000	<sup>e</sup> 55,500	24,055	53,116
Industrial..... do.....	W	W	884	16,910	W	W
Stone:						
Crushed..... do.....	<sup>e</sup> 8,900	<sup>e</sup> 25,800	7,756	22,601	<sup>e</sup> 8,300	<sup>e</sup> 26,300
Dimension..... do.....	<sup>r</sup> 40	<sup>r</sup> 13,557	37	13,598	<sup>e</sup> 28	<sup>e</sup> 10,507
Combined value of clays, lime, and values indicated by symbol W.....	XX	26,470	XX	7,271	XX	20,438
Total.....	XX	<sup>r</sup> 1,676,435	XX	1,547,958	XX	1,127,627

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



Table 2.—Nonfuel minerals produced in Minnesota in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Aitkin	Peat.
Big Stone	Stone (crushed), stone (dimension).
Blue Earth	Stone (dimension), stone (crushed).
Brown	Clays.
Carlton	Peat.
Clay	Lime.
Dakota	Stone (crushed).
Dodge	Do.
Fillmore	Do.
Goodhue	Do.
Grant	Do.
Houston	Do.
Itasca	Iron ore.
Le Sueur	Sand (industrial), stone (dimension), stone (crushed).
Mille Lacs	Stone (dimension).
Mower	Stone (crushed).
Nicollet	Do.
Olmsted	Do.
Otter Tail	Peat.
Polk	Lime.
Redwood	Clays, stone (dimension).
Renville	Lime, stone (dimension).
St. Louis	Iron ore, peat, stone (crushed).
Scott	Stone (crushed), sand (industrial).
Stearns	Stone (dimension), stone (crushed).
Steele	Stone (crushed).
Wabasha	Do.
Washington	Stone (crushed), sand (industrial).
Winona	Stone (dimension), stone (crushed).
Yellow Medicine	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Employment.**—The Minnesota Department of Economic Security reported average annual employment in the mining sector as 6,500 workers in 1986, down from the 8,300 workers reported in 1985. Average annual employment in metal mining was 4,700 persons, 27% below the 6,400 workers reported in 1985. The decline in metal mining employment was attributed to the closure of Reserve Mining operations at Babbitt and Silver Bay near the end of July and the work stoppage at USX's Minntac operation in Mountain Iron, which began on August 1 and lasted through yearend. Wages in the total mining sector averaged \$13.06 per hour in 1986, a slight increase over that of 1985. Metal mining wages averaged \$14.29 per hour compared with \$13.86 in 1985. The average number of hours worked weekly improved for both groups, 40.7 hours for total mining and 40.3 hours for metal mining.

**Exploration Activities.**—Minnesota held its 10th mineral lease sale for copper-nickel and associated minerals in 1986. Leases were offered on 1,641 mining units covering 608,000 acres in 11 counties. Twenty companies submitted 176 bids for 125 mining units totaling 50,000 acres in 6 counties. Fourteen companies were high bidders; the leases were scheduled to be awarded in early 1987. Companies receiving the greatest number of leases were Lehmann Exploration Management Inc. (27 leases, 13,026 acres), Meridian Minerals Co. (22 leases, 9,639 acres), Noranda Exploration Inc. (17 leases, 9,694 acres), and Kerr-McGee Corp. (9 leases, 4,182 acres). Among the other firms receiving leases were Normin Mining Co., a subsidiary of Boise Cascade Corp.; Longyear Mesa-ba Co.; and Rhude & Fryberger Inc.; all of which have had a long-term interest in Minnesota's minerals.

Table 3.—Indicators of Minnesota business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
Employment and labor force, annual average:			
Population	4,164	4,192	4,214
Total civilian labor force	2,229	2,221	2,213
Unemployment	6.3	6.0	5.3
Employment (nonagricultural):			
Mining total	9.4	8.3	6.5
Metal mining	7.4	6.4	4.7
Manufacturing total	373.8	375.3	369.0
Primary metal industries	6.3	6.2	6.1
Stone, clay, and glass products	8.5	8.0	7.9
Chemicals and allied products <sup>4</sup>	8.1	8.5	8.7
Petroleum and coal products <sup>4</sup>	1.6	1.6	1.5
Construction	67.6	71.3	74.6
Transportation and public utilities	96.9	98.3	97.5
Wholesale and retail trade	455.8	465.6	470.5
Finance, insurance, real estate	106.1	110.3	116.3
Services	416.6	434.4	447.8
Government and government enterprises	293.7	301.2	309.1
Total <sup>2</sup>	1,819.8	1,864.8	1,891.1
Personal income:			
Total	\$55,806	\$59,297	\$63,184
Per capita	\$13,402	\$14,147	\$14,994
Hours and earnings:			
Total average weekly hours, production workers	40.3	40.3	40.6
Mining and quarrying <sup>3</sup>	38.5	39.5	40.7
Metal mining	37.4	38.5	40.3
Total average hourly earnings, production workers	\$9.8	\$10.0	\$10.2
Mining and quarrying <sup>3</sup>	\$12.9	\$13.0	\$13.1
Metal mining	\$13.8	\$13.8	\$14.3
Earnings by industry: <sup>4</sup>			
Farm income	\$1,397	\$1,476	\$2,040
Nonfarm	\$40,052	\$42,877	\$45,503
Mining total	\$374	\$383	\$331
Metal mining	\$243	\$219	\$172
Nonmetallic minerals except fuels	\$47	\$48	\$42
Manufacturing total	\$10,134	\$10,678	\$11,069
Primary metal industries	\$192	\$178	\$189
Stone, clay, and glass products	\$214	\$214	\$217
Chemicals and allied products	\$241	\$256	\$273
Petroleum and coal products	\$71	\$72	\$72
Construction	\$2,491	\$2,689	\$2,995
Transportation and public utilities	\$3,224	\$3,345	\$3,402
Wholesale and retail trade	\$7,269	\$7,656	\$8,009
Finance, insurance, real estate	\$2,491	\$2,775	\$3,205
Services	\$8,102	\$8,984	\$9,742
Government and government enterprises	\$5,780	\$6,194	\$6,557
Construction activity:			
Number of private and public residential units authorized <sup>5</sup>	26,698	28,611	33,215
Value of nonresidential construction <sup>5</sup>	\$1,311.6	\$1,441.5	\$1,576.3
Value of State road contract awards <sup>6</sup>	\$262.7	\$433.8	\$509.0
Shipments of portland and masonry cement to and within the State <sup>7</sup>	1,213	1,459	1,511
Nonfuel mineral production value:			
Total crude mineral value	\$1,676.4	\$1,548.0	\$1,127.6
Value per capita	\$403	\$369	\$268

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Minnesota Department of Jobs and Training.<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.<sup>7</sup>Has no cement-producing plants.

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

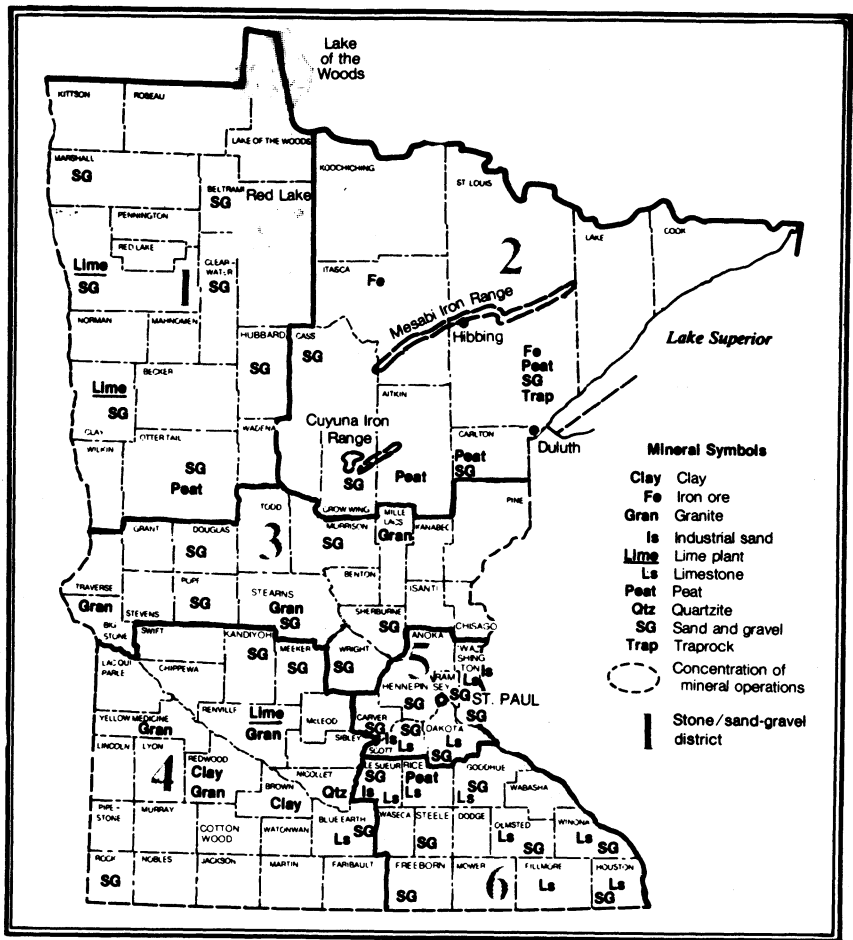


Figure 1.—Principal mineral-producing localities in Minnesota.

Exploration activity in the State focused on copper-nickel, diamonds, gold, and platinum, with major emphasis on the precious metals. As many as 22 companies were registered to do exploration drilling in the State during 1986. Eleven companies actually drilled holes, completing 46 holes in 13 counties for a total of 22,829 feet. The

Department of Natural Resources (DNR) drilled five holes in two counties for a total of 4,938 feet as part of its mineral evaluation program. Also, 10 overburden holes, totaling 943 feet, were drilled to fill in areas explored in 1985. Table 4 summarizes bedrock drilling activity in 1986.

Table 4.—Minnesota: Exploration drilling in 1986, by county

County	Number of drill holes	Total footage drilled	Company or agency
Beltrami	1	754	Newmont Exploration Ltd.
Benton	1	288	Exmin Corp.
Carlton	9	2,667	RUSC Inc.
Crow Wing	1	1,282	Minnesota Department of Natural Resources.
Koochiching	9	4,219	Cominco American Incorporated, Newmont Exploration Ltd., Normin Mining Co.
Lake of the Woods	2	1,451	Duval Corp.
Morrison	2	320	Exmin Corp.
Norman	1	309	Do.
Pope	2	2,048	Exmin Corp. and Glacier Ridge Mines Inc.
Roseau	5	3,988	Newmont Exploration Ltd.
St. Louis	12	8,790	Cyprus Mines Corp., Kerr-McGee Corp., Lehmann Exploration Management Inc., Minnesota Department of Natural Resources, St. Joe Gold Corp.
Stearns	2	458	Exmin Corp.
Todd	3	783	Do.
Wadena	1	410	Do.
Total	51	27,767	

Source: Minnesota Department of Natural Resources, Division of Minerals, Hibbing, MN.

**Legislation and Government Programs.**—Two laws related to mining and mineral resources were enacted during 1986. Chapter 403 of the 1986 session laws imposed a misdemeanor penalty on operators who intentionally file false reports to avoid paying taxes under the State's Aggregate Tax Law and eliminated the time requirement for the county auditor to notify aggregate producers or importers of unpaid taxes.

Chapter 441 modified the amount of taconite tax that comes from levies, as opposed to school aids, and imposed levy limits on towns and cities receiving distributions from the taconite municipal aid account. The law also reduced the railroad gross earnings tax and the occupation and royalty tax rates and provided for the deduction of taconite production taxes and transportation costs from the occupation tax. One section of the law appropriated \$20 million to the Commissioner of Natural Resources for use as a loan guarantee for an iron smelting project using the COREX process, contingent upon the commissioner's receiving funding from other sources to complete the project.

The Minnesota Geological Survey, a division of the School of Earth Sciences, Institute of Technology, University of Minnesota, continued its programs in geology, hydrogeology, geochemistry, and geophysics. Stratigraphic and geochemical studies of basal tills in northeastern Minnesota were conducted in cooperation with the DNR's Minerals Division to provide guidance for ongoing gold exploration activities. Stratigraphic work continued on Cretaceous rock strata in southwestern Minnesota that had potential for manganese. Red-

beds in the Midcontinent Rift system were also evaluated as possible hostrock for sedimentary copper.

The Mineral Resources Research Center (MRRC) of the University of Minnesota completed a project in applied process mineralogy funded by the Legislative Commission on Minnesota Resources and established a QEM-SEM laboratory for the quantitative evaluation of materials using scanning electron microscopy. The QEM-SEM laboratory is now available as a service bureau that provides advanced mineralogical analysis for the North American mineral industry. Two mining directories were published by the MRRC: one covering the iron mining industry and the other covering industrial minerals.

The Natural Resources Research Institute (NRRI) in Duluth conducted several studies regarding the State's mineral resources and mining. Researchers investigated the use of taconite tailings in concrete blocks, ceramics, and for sandblasting. Other studies involved the precious-metal potential of the Duluth Gabbro Complex and the use of Minnesota clay resources for building materials. In July, NRRI acquired the USX mineral research laboratory at Coleraine, MN, along with most of its personnel. Under the sales agreement, USX will contract its research needs on mineral beneficiation and agglomeration with NRRI.

Minnesota received \$576,000 as its share of funds generated by activities (mineral leasing, recreation, timbering, etc.) on national forest lands from the Federal Government in fiscal year 1986.

The U.S. Bureau of Mines expended about \$760,000 for contracts, grants, equipment, and services by Minnesota firms in fiscal year 1986. The Bureau also distributed \$142,000 to the MRRC as part of a program to assist the research institute's efforts to train engineers and scientists in mineral-related disciplines. Research funds totaling \$346,895 were also awarded for projects in the Bureau's Mineral Institute Generic Center programs in the areas of comminution, mine waste, and respirable dust.

Drillcore from the Bureau's core repository in the Twin Cities was transferred under a long-term loan arrangement to the DNR Minerals Division facilities in Hibbing during 1986. About 381,000 feet of drillcore from 53 Minnesota counties was integrated with the State's core library to provide greater convenience to explorationists under the State's program to promote mineral development.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

Minnesota was the leading producer of iron ore in the Nation, accounting for 70% of total U.S. shipments. All of the State's output originated on the Mesabi Range—Iasca and St. Louis Counties. Eight companies reported shipments during 1986 from 7 taconite plants, 2 natural iron ore proper-

ties, and stockpiles at 10 locations. Shipments fell to their lowest level since 1982, about 18% compared with 1985 figures, because of weak demand, a long work stoppage, and closure of a large pellet plant and mine. Value of shipments declined even more, about 29%, because of competitive pricing in the taconite market.

**Table 5.—Minnesota: Production and shipments of usable iron ore<sup>1</sup>**

(Thousand long tons, gross weight, unless otherwise specified)

Year	Production				Shipments			Proportion of pellets to total ore (percent)
	Natural ore and concentrates	Pellets	Total <sup>2</sup>	Iron content (percent)	Natural ore and concentrates	Pellets	Total <sup>2</sup>	
1982 --	527	23,372	23,898	64.7	752	22,963	23,715	96.8
1983 --	865	25,390	26,255	64.4	1,113	29,586	30,699	96.4
1984 --	853	35,844	36,697	64.7	1,193	34,409	35,602	96.7
1985 --	1,462	33,448	34,910	64.2	1,458	33,519	34,977	95.8
1986 --	1,124	25,882	27,005	64.4	1,345	27,435	28,779	95.3

<sup>1</sup>Exclusive of ore containing 5% or more manganese.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

**Table 6.—Minnesota: Salient taconite plant information for 1986**

Operation	Owner	Managing company	Rated annual pellet capacity (million long tons)	Number of days shut down
Erie Mining Co ----- Eveleth Mines -----	LTV Steel Co., 100% Eveleth Taconite Co. (2.3-million-ton capacity); Rouge Steel Co., 85%; Oglebay Norton Co., 15% Eveleth Expansion Co. (3.7-million-ton capacity); Armco Inc., 56%; Stelco Inc., 23.5%; Oglebay Norton Co., 20.5%	Pickands Mather & Co Oglebay Norton Co --	11.0 6.0	131 46
Hibbing Taconite Co -----	Bethlehem Steel Corp., 70.3%; Cliffs Mining Co., 15%; Stelco Inc., 14.7%	Pickands Mather & Co	8.1	64
Minnnac <sup>1</sup> ----- Minorca ----- National Steel Pellet Co -----	USX Corp., 100% Inland Steel Co., 100% National Steel Corp., 100%	USS Inc ----- Inland Steel Mining Co M. A. Hanna Co -----	18.5 2.0 4.5	178 99 81
Reserve Mining Co. <sup>2</sup> -----	Armco Inc., 50%; LTV Steel Co., 50%.	Pickands Mather & Co	8.4	193

<sup>1</sup>Contract dispute resulted in work stoppage that began Aug. 1 and continued through yearend.

<sup>2</sup>Operations suspended indefinitely following bankruptcy filing by LTV Steel Co.

**Table 7.—Minnesota: Salient statistics on employment and wages at iron ore mines in Itasca and St. Louis Counties**

County and year	Mines shipping <sup>1</sup>	Employees	Lost-time injuries	Fatalities	Average wages per day
<b>Itasca:</b>					
1982	3	375	3	---	\$94.88
1983	3	399	3	---	92.95
1984	3	451	---	---	94.75
1985	3	590	3	---	97.68
1986	2	106	---	---	97.68
<b>St. Louis:</b>					
1982	16	7,626	44	---	94.19
1983	17	5,935	50	2	84.19
1984	14	6,305	55	---	87.39
1985	17	5,539	29	---	90.60
1986	15	5,250	33	---	94.19

<sup>1</sup>Includes producing mines and mines with only stockpile shipments.

Source: Annual Reports of the Inspectors of Mines, Itasca and St. Louis Counties, MN, 1986.

Approximately 94% of Minnesota's iron ore shipments was transported on Great Lakes carriers to consumers. The remain-

der was hauled by rail to the point of use. Table 8 summarizes Minnesota iron ore loadings at various ports.

**Table 8.—Salient statistics for ports shipping Minnesota iron ore**

Year, port, and dock	Date of first shipment	Date of last shipment	Number of shipments	Total shipments (gross tons)	Average shipment (gross tons)	Largest shipment (gross tons)
<b>1985:</b>						
Duluth, MN: DM&IR	Apr. 2	Dec. 15	209	6,132,547	29,342	63,401
Silver Bay, MN: Reserve	Apr. 7	Dec. 14	57	3,426,100	60,107	64,188
Superior, WI: Burlington-Northern	Apr. 5	Dec. 22	201	8,506,371	42,320	63,231
Taconite Harbor, MN: Erie	Apr. 5	Dec. 21	172	4,971,963	28,907	62,262
Two Harbors, MN: DM&IR	Apr. 3	Dec. 21	195	8,719,429	44,715	63,440
Total or average	-----		834	31,756,410	38,077	64,188
<b>1986:</b>						
Duluth, MN: DM&IR	Apr. 5	Dec. 24	163	5,034,790	30,888	63,781
Silver Bay, MN: Reserve	Apr. 12	July 15	26	1,449,669	55,757	63,324
Superior, WI: Burlington-Northern	Apr. 8	Dec. 24	195	8,998,170	46,144	64,390
Taconite Harbor, MN: LTV	Apr. 11	Dec. 28	135	5,456,744	40,420	63,587
Two Harbors, MN: DM&IR	Apr. 1	Dec. 14	135	6,155,788	45,598	63,288
Total or average	-----		654	27,095,161	41,430	64,390

Source: Annual Reports of Lake Carriers' Association, 1985 and 1986.

Published rail and water freight rates for transporting iron ore from the Mesabi Range to lower lake ports ranged from \$12.42 to \$13.79 per long ton at midyear.<sup>2</sup>

All taconite operations reported some downtime during 1986, either for maintenance, vacation time, or because of the inability of steel company partners to take additional pellets. LTV Corp., the Nation's second largest steel producer, filed for reorganization under chapter 11 of the Federal Bankruptcy Code in July. Following this action, Reserve, jointly owned by LTV Steel Co., a subsidiary of LTV Corp., and Armco Inc., was shut down indefinitely on July 21. Armco's subsidiary, First Taconite Corp., part owner in the Reserve operation, filed

for chapter 11 protection on August 7, effectively placing the Reserve operations under bankruptcy court jurisdiction where they remained at yearend. Reserve's operations at Babbitt and Silver Bay employed about 750 people.

The USS Minntac plant and mine at Mountain Iron closed on August 1 because of a nationwide work stoppage at USX iron and steel operations. Ruled a lockout by State officials, approximately 1,250 union workers were placed on the unemployment rolls. Numerous salaried personnel also were laid off in the following months because work stoppage extended through yearend. All other iron mining firms reached new contract agreements with their

**unions worked under extensions of old contracts during 1986.**

Several ownership and management changes occurred in the State's iron ore operations in 1986. In March, Pickands Mather & Co. assumed management responsibilities for the Reserve operations at Babbitt and Silver Bay. Approximately 105 persons were laid off as a result. In May, LTV Steel revamped its holdings and acquired a full ownership interest in Erie Mining Co. in Hoyt Lakes. LTV Steel increased its share in Erie from 35% to 100% by exchanging a 16% share in Hibbing Taconite Co. and a 12.5% share in Iron Ore of Canada with Bethlehem Steel Corp., Interlake Inc., and Steel Co. of Canada (Stelco). Hibbing Taconite became owned by Bethlehem Steel (70.3%), Pickands Mather (15%), and Stelco (14.7%). At yearend, Cleveland-Cliffs Inc. acquired Pickands Mather from Moore McCormack Resources Inc. Pickands Mather managed Erie Mining, Hibbing Taconite, and Reserve and had equity interests in Hibbing Taconite.

Late in the year, Inland Steel Co. announced it would convert its Minorca operations at Virginia to production of "fluxed" pellets. Construction and renovation were expected to begin in 1987. USX had converted one pelletizing line at the Minntac plant for testing fluxed pellets just before the work stoppage began at USX facilities.

#### INDUSTRIAL MINERALS

**Clays.**—Two companies produced clay in 1986. Ochs Brick & Tile Co. mined common clay in Brown County and a kaolin-type clay in Redwood County to support its brick manufacturing facility near Springfield, Brown County. Northwestern States Portland Cement Co. had a contractor (Schmidt Construction Co.) mine a kaolin-type clay near Redwood Falls, Redwood County, that was shipped by rail to its Mason City, IA, plant for use in manufacturing cement. Both production and value increased substantially during 1986 with the addition of Northwestern States' production to the State's total.

**Gem Stones.**—Rockhounds and mineral dealers collected a variety of mineral specimens and semiprecious gem stones (mainly agates) from the State's mine dumps, gravel pits, and shoreline of Lake Superior. Value was estimated to be \$5,000 in 1986. Exmin Corp. explored for diamonds in 1986, drilling holes in Benton, Morrison, Norman, Pope, Stearns, Todd, and Wadena Counties.

Results of the drilling program were not released.

**Lime.**—Two companies produced quicklime in 1986. Production and value increased 39% and 47%, respectively. American Crystal Sugar Co. operated plants at Moorhead, Clay County; and Crookston and East Grand Forks, Polk County. Southern Minnesota Sugar Co-op. operated a plant in Renville County. All limestone consumed in the manufacturing process was from out-of-State sources. Lime consumption in the State, from all domestic sources, totaled 229,000 short tons of quicklime and 18,000 short tons of hydrated lime.

**Peat.**—Nationally, Minnesota ranked sixth of 22 States in sales of peat. Sales and value of sales decreased 21% and 26%, respectively. Hypnum, reed-sedge, and sphagnum peat were produced by four companies in Aitkin, Carlton, Otter Tail, and St. Louis Counties. Another company, Eli Colby Co., harvested peat from a Rice County bog in southern Minnesota and trucked it to its Iowa plant for processing. Production from this operation is included in Iowa statistics. Most of the peat produced in the State was the reed-sedge type. Approximately 90% of the State sales were used for general soil improvement and as an ingredient for potting soil. Other sales were to golf courses and nurseries and for use as earthworm culture medium.

MAT Inc., a new company that started operations in Carlton County late in 1985, received a \$247,500 Community Development Grant channeled through the City of Floodwood to purchase additional equipment and enlarge its manufacturing operation. The company processed peat to manufacture a peat, wood, and textile mat filled with grass seed that is designed to encourage grass to grow in hot, arid climates. Peat for the process was purchased from a nearby producer.

In June, ground-breaking ceremonies were held in North Branch, Chisago County, for a plant being built by Northern Resources Conversion Inc. that will use peat in its product, a pelletized molasses feed supplement for cattle. Peat will also be burned for drying and as fuel for the manufacturing process.

**Perlite (Expanded).**—USG Acoustical Products Co., a subsidiary of USG Corp., expanded crude perlite mined in western States at its plant near Cloquet in Carlton County. USG purchased the plant in August 1985 from Conwed Corp., which manufac-

tured acoustical ceiling tile at the site.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter con-

tains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

**Table 9.—Minnesota: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,237	\$12,163	\$2.87
Plaster and gunite sands	100	432	4.32
Concrete products (blocks, bricks, pipe, decorative, etc.)	410	1,015	2.48
Asphaltic concrete aggregates and other bituminous mixtures	4,416	9,027	2.04
Road base and coverings <sup>1</sup>	5,525	9,935	1.79
Fill	1,891	2,777	1.47
Snow and ice control	119	281	2.36
Roofing granules	16	173	10.77
Other <sup>2</sup>	168	536	3.19
Other unspecified <sup>3</sup>	7,172	16,777	2.34
Total or average	<sup>4</sup> 24,055	53,116	2.21

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes railroad ballast and other specified uses.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data do not add to total shown because of independent rounding.

**Table 10.—Minnesota: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup>	487	1,620	100	514	555	1,208
Asphaltic concrete aggregates and other bituminous mixtures	390	1,125	354	628	507	876
Road base and coverings <sup>2</sup>	1,057	1,937	857	1,429	1,479	2,241
Fill	146	308	189	360	82	123
Snow and ice control	12	26	12	46	18	27
Roofing granules	16	173	--	--	--	--
Other	66	234	--	--	8	68
Other unspecified <sup>3</sup>	1,504	3,398	771	2,025	1,013	1,959
Total <sup>4 5</sup>	3,668	8,820	2,283	5,002	3,662	6,503
	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup>	289	838	2,843	7,567	474	1,863
Asphaltic concrete aggregates and other bituminous mixtures	W	W	2,649	5,506	W	W
Road base and coverings <sup>2</sup>	585	1,003	1,184	2,693	287	556
Fill	110	188	989	1,829	374	469
Snow and ice control	W	W	W	W	52	136
Roofing granules	--	--	--	--	--	--
Other	W	W	W	W	W	W
Other unspecified <sup>3</sup>	2,164	4,707	835	1,666	1,298	3,845
Total <sup>4 5</sup>	3,148	6,736	8,501	18,761	2,485	6,870

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes railroad ballast, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Excludes 309,000 short tons valued at \$425,000 not reported by county.

<sup>5</sup>Data may not add to totals shown because of independent rounding.



**Construction sand and gravel** was the State's second ranking mineral commodity in value, following iron ore. Sales and value of sales declined about 4% compared with figures estimated for 1985. Production was by 203 companies at 424 pits in 82 of the State's 87 counties. The Twin Cities metropolitan counties of Dakota, Hennepin, and Washington each recorded production in excess of 1 million short tons and together accounted for 29% of the State total.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 10 presents end-use data for construction sand and gravel produced in the six Minnesota districts depicted in figure 1.

**Industrial.**—Minnesota Frac Sand Co.'s operation near Jordan in Scott County was sold to Unimin Corp. in August 1986, leaving Unimin and Twin City Silica Ltd. as the only producers of industrial sand in the State. Unimin also had two operations in Le Sueur County, and Twin City Silica had an operation near Woodbury in Washington County. Production and value declined during the year. Most industrial sand sales were for hydraulic fracturing (50%); other major sales were for glass containers (14%), sandblasting (14%), and foundry molding and core use (12%). Shipments to consumers were by rail (54%) and truck (46%).

**Slag—Iron and Steel.**—International Mill Service Co. processed steel slag from North Star Steel Co.'s St. Paul mill. Most of the output was used as construction material. Sales declined about 23% during 1986.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered

years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone sales and attendant value were estimated to have increased 7% and 16%, respectively. Total value of sales set a record high for the State in 1986.

**Dimension.**—Dimension stone sales and attendant value were estimated to have declined 24% and 23%, respectively. Foreign imports were reported to have adversely affected sales.

**Sulfur (Recovered).**—Elemental sulfur was recovered by Koch Refining Co., a division of Koch Industries Inc., at a refinery near Pine Bend in Dakota County and by Northwestern Refining Co., a division of Ashland Oil Co., at a refinery near St. Paul Park, Washington County. Sales and attendant value of sales increased 18% and 28%, respectively. Average value per metric ton increased \$7.07.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. continued to exfoliate vermiculite obtained from out-of-State sources at its plant in Minneapolis, Hennepin County. Sales increased slightly during 1986, and average value per short ton increased \$48.20. In order of use, sales were for block insulation, fireproofing, loose-fill insulation, horticulture, concrete aggregate, and plaster aggregate.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Skilling's Mining Review. Rail and Lake Freight Rates on Iron Ore and Pellets Per Gross Ton. V. 75, No. 31, Aug. 2, 1986, p. 20.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Pit	Redwood.
Ochs Brick & Tile Co	Box 106 Springfield, MN 56087	Pits and plant	Brown and Redwood.
<b>Iron ore:</b>			
M. A. Hanna Co.:	100 Erieview Plaza Cleveland, OH 44114		
Butler Taconite Project		Stockpile shipments.	Itasca.
National Steel Pellet Project		Mine, concentrator, agglomerator.	Itasca and St. Louis.
Inland Steel Mining Co.:	30 West Monroe St. Chicago, IL 60603		
Minorca		do	St. Louis.
LTV Steel Co., Northwest Ore Div.:	Box 196 Aurora, MN 55705		
McKinley		Stockpile shipments.	Do.
McKinley Extension		Mine and concentrator.	Do.
Oglebay Norton Co.:	1100 Superior Ave. Cleveland, OH 44114		
Eveleth Mines		Mine, concentrator, agglomerator.	Do.
Pickands Mather & Co.:	1100 Superior Ave. Cleveland, OH 44114		
Erie Mining Co		do	Do.
Hibbing Taconite Co		do	Do.
Reserve Mining Co		Mine and primary crusher.	Do.
Do		Concentrator and agglomerator.	Lake.
Pittsburgh Pacific Co	2521 1st Ave. Hibbing, MN 55746	Stockpile shipments from 7 properties.	St. Louis.
Rhude & Fryberger Inc.:	Box 66 Hibbing, MN 55746		
Plummer-Diamond		Stockpile shipments.	Itasca.
Rana		Mine and plant	St. Louis.
USX Corp., Minnesota Ore Operations: Minntac	Box 417 Mountain Iron, MN 55768		
		Mine, concentrator, agglomerator.	Do.
<b>Lime:</b>			
American Crystal Sugar Co	101 North 3d St. Moorhead, MN 56560	Plants	Clay and Polk.
Southern Minnesota Sugar Co-op	Box 500 Renville, MN 56284	Plant	Renville.
<b>Peat:</b>			
Aitkin Agri-Peat	Fleming Route, Box 35 Aitkin, MN 56431	Bog and plant	Aitkin.
Eli Colby Co	Box 248 Lake Mills, IA 50450	Bog	Rice.
Michigan Peat Co	Box 66388 Houston, TX 77266	Bog and plant	Carlton.
Power-O-Peat Co	Box 956 Gilbert, MN 55741	do	St. Louis.
Tamarack Peat Moss Co	Underwood, MN 56586	do	Otter Tail.
Perlite (expanded): USG Acoustical Products Co., a subsidiary of USG Corp.	Arch St. Cloquet, MN 55720	Plant	Carlton.
<b>Sand and gravel:</b>			
Construction:			
Barton Contracting Co	10633 89th Ave. North Osseo, MN 55369	Pits and plants	Benton, Dakota, Hennepin, Sherburne, Washington, Wright.
Fairway Construction Co	Box 426 Hector, MN 55342	do	Various.
Lundin Construction Co. Inc	1905 3d Ave. Mankato, MN 56001	do	Carlton, Rice, Steele.
North Star Concrete Co	Box 167 Mankato, MN 56001	do	Le Sueur and Nicollet.
Prior Lake Aggregates Inc	8680 West 158th St. Prior Lake, MN 55372	Pit and plant	Scott.
J. L. ShIELy Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Washington.
Stommes Construction Co	Route 4 St. Cloud, MN 56301	Pits and plants	Hennepin, Hubbard, Sherburne, Stearns.
<b>Industrial:</b>			
Twin City Silica Ltd	499 Cottage Grove Dr. Woodbury, MN 55125	Pit and plant	Washington.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Industrial —Continued			
Unimin Corp .....	258 Elm St. New Canaan, CT 06840	Pits and plants ...	Le Sueur and Scott.
Slag—iron and steel:			
International Mill Service Co .....	1818 Market St. Philadelphia, PA 19103	Plant .....	Washington.
Stone (1985):			
Crushed:			
Granite:			
The Green Co. Inc .....	200 14th Ave. Granite Falls, MN 56241	Quarry and plant ..	Yellow Medicine.
Ortonville Stone Co., a subsidiary of L. G. Everist Inc.	Box 829 Sioux Falls, SD 57102	...do .....	Big Stone.
J. L. Shiely Co .....	1101 North Snelling Ave. St. Paul, MN 55108	...do .....	Stearns.
Limestone:			
Bryan Rock Products Inc. ...	Box 215 Shakopee, MN 55379	...do .....	Scott.
Kappers Construction Co. Inc.	133 South Broadway Spring Valley, MN 55975	Quarries and plants	Fillmore.
Edward Kraemer & Sons Inc.	1000 West Cliff Rd. Burnsville, MN 55337	Quarry and plant ..	Dakota.
Mankato Aglime & Rock Co	Box 254 Mankato, MN 56001	...do .....	Blue Earth.
Mathy Construction Co., Patterson Quarries Div.	Route 3, Box 15 St. Charles, MN 55972	Quarries and plants	Olmsted, Wabasha, Winona.
Midwest Asphalt Corp., River Warren Aggregates Inc.	Box 338 Hopkins, MN 55343	Quarry and plant ..	Scott.
Quarve & Anderson Co. ...	2438 Marion Rd. SE. Rochester, MN 55901	Quarries and plants	Dodge, Goodhue, Olmsted, Wabasha, Winona.
J. L. Shiely Co .....	1101 North Snelling Ave. St. Paul, MN 55108	...do .....	Scott and Washington.
Quartzite:			
New Ulm Quartzite Quarries Inc.	Route 5, Box 21 New Ulm, MN 56073	Quarry and plant ..	Nicollet.
Traprock (basalt):			
Arrowhead Blacktop Co. ...	Box 6568 Duluth, MN 55806	...do .....	St. Louis.
Dimension:			
Granite:			
Cold Spring Granite Co. ...	Cold Spring, MN 56320	Quarries .....	Big Stone, Mille Lacs, Renville.
Do .....	-----	Quarries and plant	Stearns.
View Quarry Co., a division of Rex Granite Co.	Box 924 St. Cloud, MN 56302	Quarry and plant ..	Redwood.
Limestone:			
Biesanz Stone Co. Inc. ...	Box 768 Winona, MN 55987	...do .....	Winona.
Minnesota Quarries Inc. ...	Box 1358 Mankato, MN 56002	...do .....	Blue Earth.
Vetter Stone Co .....	Route 5, Box 41 Mankato, MN 56001	Quarries and plant	Blue Earth and Le Sueur.
Sulfur (recovered):			
Ashland Petroleum Co., a division of Ashland Oil Inc.	Box 391 Ashland, KY 41101	Elemental sulfur recovered as a by-product of oil refining.	Washington.
Koch Refining Co., a division of Koch Industries Inc.	Box 2302 Wichita, KS 67201	...do .....	Dakota.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	62 Whittemore Ave. Cambridge, MA 02140	Processing plant ...	Hennepin.

# The Mineral Industry of Mississippi

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

By James R. Boyle<sup>1</sup>

The value of Mississippi's nonfuel mineral production in 1986 was \$101.1 million, a slight decrease from that of 1985. The decrease in value reversed an upward trend that had occurred for the last 3 years. However, Mississippi's overall economy remained one of the weakest in the Southeast, and minerals output was still below the peak years of 1978 through 1980.

Commodities produced were cement, clays, sand and gravel, and stone. Although not considered a major mining State, Mississippi ranked high nationally in output of specialty clays—ball clay, bentonite, and fuller's earth. Mississippi also had a small

metals sector.

**Trends and Developments.**—Construction activities both within Mississippi and in adjacent regions determined the output of the State's minerals operations. Average annual employment in the Mississippi construction industry declined slightly, as did housing starts. Mining employment in the nonfuels sector remained at about the same level as that of 1985. The unemployment rate remained in double digits in 1986, increasing from slightly over 10% in 1985 to nearly 12% in 1986. Forecasts project limited growth, which will be below national levels.<sup>2</sup>

Table 1.—Nonfuel mineral production in Mississippi<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons. . . . .	<sup>2</sup> 1,274	<sup>r</sup> \$10,367	1,558	\$34,864	<sup>2</sup> 928	<sup>2</sup> \$13,538
Gem stones -----	---	---	---	---	NA	1
Sand and gravel (construction) -----	---	---	---	---	---	---
thousand short tons. . . . .	12,205	34,955	<sup>e</sup> 13,400	<sup>e</sup> 42,000	15,080	42,809
Stone (crushed) ----- do. . . . .	<sup>e</sup> 2,000	<sup>e</sup> 5,800	1,582	4,282	<sup>e</sup> 1,600	<sup>e</sup> 4,400
Combined value of cement, clays (ball clay and fuller's earth, 1984, 1986), and sand and gravel (industrial). . . . .	XX	42,016	XX	21,647	XX	40,347
Total -----	XX	<sup>r</sup> 93,138	XX	102,793	XX	101,095

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. XX Not applicable.

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

<sup>2</sup>Excludes certain clays; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Mississippi in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Benton	Clays.
Clay	Stone (crushed).
Hinds	Clays.
Jackson	Sand (industrial).
Jones	Clays.
Kemper	Do.
Lee	Stone (crushed).
Lincoln	Clays.
Lowndes	Cement, stone (crushed), clays.
Marshall	Clays.
Monroe	Do.
Noxubee	Do.
Panola	Do.
Smith	Stone (crushed).
Tippah	Clays.
Tishomingo	Stone (crushed), sand (industrial).
Wayne	Stone (crushed).
Winston	Clays.
Undistributed <sup>2</sup>	Sand and gravel (construction).

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Mississippi business activity

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	2,599	2,614	2,625
Total civilian labor force	do.	1,074	1,129	1,163
Unemployment	percent	10.8	10.3	11.7
<b>Employment (nonagricultural):</b>				
Mining total	thousands	9.1	8.9	6.9
Nonmetallic minerals except fuels <sup>1</sup>	do.	.7	.8	.8
Oil and gas extraction	do.	8.4	8.1	6.1
Manufacturing total	do.	218.7	221.6	222.9
Primary metal industries <sup>1</sup>	do.	3.9	4.0	3.7
Stone, clay, and glass products	do.	6.1	5.6	5.7
Chemicals and allied products	do.	6.8	6.5	6.5
Petroleum and coal products	do.	2.1	2.1	2.0
Construction	do.	37.1	36.7	35.7
Transportation and public utilities	do.	39.1	39.1	39.4
Wholesale and retail trade	do.	173.6	177.5	182.9
Finance, insurance, real estate	do.	34.2	35.6	37.3
Services	do.	125.8	130.6	134.1
Government and government enterprises	do.	183.2	188.5	189.8
Total	do.	820.8	<sup>2</sup> 838.9	849.0
<b>Personal income:</b>				
Total	millions	\$23,175	\$24,258	\$25,504
Per capita	do.	\$8,916	\$9,279	\$9,716
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do.	40.6	40.6	40.2
Total average hourly earnings, production workers	do.	\$7.0	\$7.2	\$7.5
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$677	\$601	\$484
Nonfarm	do.	\$15,426	\$16,314	\$17,107
Mining total	do.	\$255	\$263	\$205
Nonmetallic minerals except fuels	do.	\$14	\$14	\$12
Oil and gas extraction	do.	\$242	\$249	\$193
Manufacturing total	do.	\$4,079	\$4,285	\$4,478
Primary metal industries	do.	\$91	\$98	\$92
Stone, clay, and glass products	do.	\$121	\$115	\$123
Chemicals and allied products	do.	\$179	\$185	\$191
Petroleum and coal products	do.	\$93	\$94	\$94
Construction	do.	\$882	\$897	\$920
Transportation and public utilities	do.	\$1,106	\$1,140	\$1,175
Wholesale and retail trade	do.	\$2,558	\$2,663	\$2,767
Finance, insurance, real estate	do.	\$693	\$741	\$850
Services	do.	\$2,579	\$2,842	\$3,061
Government and government enterprises	do.	\$3,163	\$3,382	\$3,548

See footnotes at end of table.

Table 3.—Indicators of Mississippi business activity —Continued

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> -----	11,638	8,757	8,289
Value of nonresidential construction <sup>4</sup> ----- millions --	\$304.1	\$323.1	\$412.7
Value of State road contract awards <sup>5</sup> ----- do. -----	\$235.2	\$242.0	\$178.7
Shipments of portland and masonry cement to and within the State thousand short tons --	850	815	882
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions --	\$93.1	\$102.8	\$101.1
Value per capita -----	\$36	\$39	\$39

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

The recently opened Tennessee-Tombigbee Waterway handled twice the tonnage in 1986 as in 1985.<sup>3</sup> About 3.6 million short tons was handled in 1986, primarily mineral commodities: 1.3 million tons of coal, 700,000 tons of crushed rock, and 300,000 tons of fuel. Because of the limited supply of crushed stone along the gulf coast, crushed stone was being barged from Kentucky and marketed not only along the gulf but at points along the waterway.

Kerr-McGee Chemical Corp. announced plans to expand its titanium dioxide facility at Hamilton from 72,000 to 93,000 short tons per year.<sup>4</sup> The \$25 million expansion was scheduled to begin early in 1987, with completion by late 1988; this is the third expansion at the facility since 1983. The company's synthetic rutile plant at Mobile, AL, provides feedstock for the Hamilton facility. Kerr-McGee also produces electrolytic manganese at Hamilton.

During fiscal year 1986, 195,893 short tons of ilmenite was imported through the Port of Gulfport, down from 225,215 tons in fiscal year 1985. The ilmenite was destined for E. I. du Pont de Nemours & Co. Inc.'s titanium dioxide operations at Pass Christian.

**Legislation and Government Programs.**—The Mississippi Bureau of Geology and Energy Resources continued investigation of the geology and mineral resources of the State. The Environmental Section provided assessment of sanitary landfills and hazardous wastesites. The Ground-Water Section compiled and distributed information concerning the water resources of the State. Field investigations of the water resources of Kemper, Lauderdale, and Neshoba Counties continued. The Mineral Lease Section leased State-owned property

and processed applications for geophysical permits. Income from leasing, royalty, and permit activities increased by 170% to \$4.4 million. The Surface Section issued Bulletin 126, "Newton County Geology and Mineral Resources," and continued field investigations in Tishomingo County. The Subsurface Section maintained the Sample and Core Library and continued regional subsurface mapping. The Surface Mining Section regulated the surface mining industry, issuing an increasing number of new mining permits.

The Mississippi Minerals Resources Institute (MRI) mineral resource investigations during the year included exploration and evaluation of minerals off the Mississippi coast, use of natural zeolites, and several energy-related studies involving both lignite and oil and gas. With financial support from the U.S. Department of the Interior, the States of Alabama, Louisiana, and Mississippi will explore the Gulf of Mexico's floor for nonfuel mineral deposits that could be developed. MRI will represent the State in a joint study with the U.S. Department of the Interior and the States of Alabama and Louisiana.

The issue of offshore oil and gas revenues from Federal leases to be shared with Mississippi and other coastal States under section 8(g) of the Outer Continental Shelf Lands Act of 1978 was settled early in 1986. Legislation was signed giving coastal States 27% of all oil and gas revenues earned in the zone adjacent to their borders from September 1978 to October 1986. Distribution of income earned after October 1986 will be determined on the basis of the portion of a Federal tract actually within the zone. Mississippi's initial share was \$14 million.

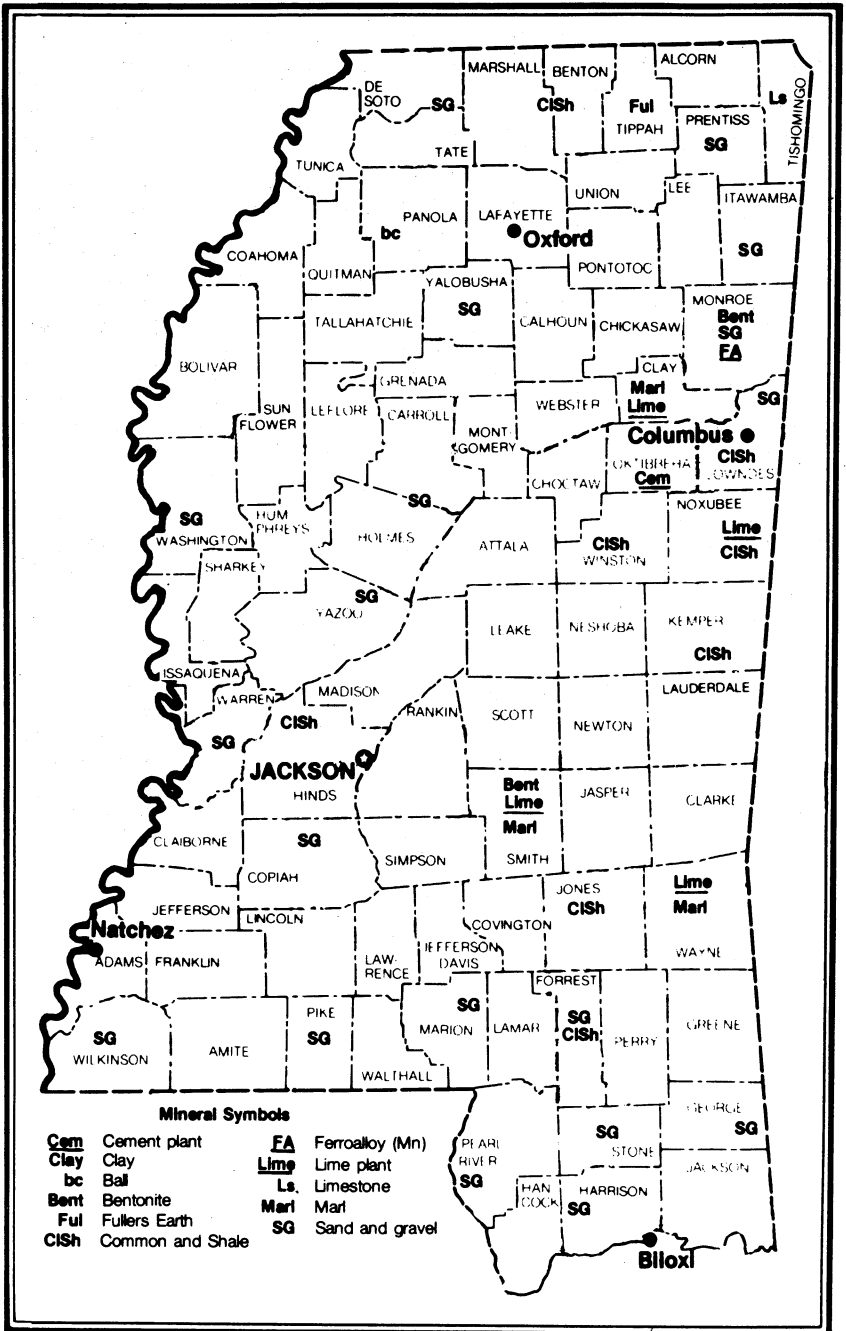


Figure 1.—Principal mineral-producing localities in Mississippi.

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

Industrial minerals accounted for all of Mississippi's nonfuel mineral production in 1986.

**Cement.**—United Cement Co., Artesia, was the only cement producer in the State. Primary output was portland cement, with minor amounts of masonry cement being produced. Portland cement shipments increased while masonry cement shipments decreased. Unit prices of portland increased while that of masonry decreased.

Raw materials used in cement manufacture included anhydrite, chalk, gypsum, iron ore, limestone, and sand. Raw materials used were mined locally or in adjacent States. The cement was shipped to markets in the Southeast.

**Chromium.**—Corhart Refractories Co. Inc., Pascagoula, imported chrome ore for the production of refractories. The primary use was in the form of chromite to make refractory bricks for lining metallurgical furnaces.

**Clays.**—Mississippi's clay industry consisted of 14 companies operating 27 mines in 12 counties, primarily in the northern and northeastern parts of the State. Ball clay, bentonite, common clay, and fuller's earth were produced in the State. Mississippi ranked second nationally in output of ball clay and bentonite, and third in fuller's earth. Output of total clays decreased from that of 1985.

Common clay was mined at 18 pits, primarily in Hinds, Kemper, and Noxubee Counties. Major uses were for brick, concrete block, and highway surfacing. Output was 616,672 short tons compared with 850,706 tons in 1985.

Ky-Tenn Clay Co., Panola County, was the only producer of ball clay in the State. The clay was utilized mainly for ceramic applications.

Mississippi's three bentonite producers operated three mines in Monroe County.

Demand increased and reached its highest level of output since 1979.

Production and value of fuller's earth decreased from that of 1985. Three companies mined fuller's earth from open pits in Tippah County. A variety of granular and powdered absorbent mineral products were produced.

**Nitrogen.**—Cargill Inc., Chevron Chemical Co., and Mississippi Chemical Corp. produced anhydrous ammonia during 1986. Total rated annual capacity of the three facilities was 991,000 short tons. Late in the year, Chevron stopped producing anhydrous ammonia at its plant at Pascagoula. Spot ammonia prices on the gulf coast reportedly dropped 30% during the year.

**Perlite (Expanded).**—Mississippi ranked first nationally in the output of expanded perlite. Manville Products Corp., Natchez, and USG Corp., Greenville, expanded perlite shipped in from New Mexico. Production and value increased over that of 1985.

**Sand and Gravel.**—Mississippi produced both construction sand and gravel and industrial sand in 1986. Production was from 76 companies operating 116 pits in 35 counties. Total output increased over that of 1985. None of the operations in the State produced over 1 million short tons in 1986.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was the leading commodity in value among the nonfuel minerals produced in Mississippi. Although production increased, it still had not returned to its peak production years of the 1970's. Construction sand and gravel was produced at 103 operations in 34 counties. Leading counties were Copiah, DeSoto, and Harrison. Nearly all of the sand and gravel was shipped by truck.



**Table 4.—Mississippi: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	3,433	\$13,072	\$3.81
Plaster and gunitite sands -----	32	82	2.56
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	W	W	7.25
Asphaltic concrete aggregates and other bituminous mixtures -----	1,151	3,580	3.11
Road base and coverings -----	1,612	3,845	2.39
Fill -----	1,251	1,846	1.48
Other -----	258	971	3.76
Other unspecified <sup>1</sup> -----	7,342	19,414	2.64
Total <sup>2</sup> or average -----	15,080	42,809	2.84

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Sand for industrial uses was produced by two companies in Jackson and Tishomingo Counties. Output increased, and the material was used in sandblasting and molds and for foundry cores.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone output for 1986 was estimated at about the same as that of 1985 because construction and road maintenance activities remained at the same level as that of 1985.

Markets in the area were being supplied to some extent by out-of-State quarries utilizing the newly completed Tennessee-Tombigbee Waterway. Several storage yards along the waterway were completed and effectively competed against local suppliers.

The Mississippi Department of Agriculture and Commerce's Lime Division mines and sells crushed limestone at cost to Mississippi farmers. Opposition to these State-operated lime plants in Macon, Waynesboro, and West Point increased as agricultural markets diminished. Opposition centered on charges that the plants operated at a loss and sold below cost. In legislative action, a bill proposing to close the Lime Division was defeated, and the State planned to continue to operate the lime plants for the farmers of Mississippi. In 1986, seven companies produced limestone and marl at nine quarries in seven counties.

**Sulfur (Recovered).**—Mississippi ranked second in the Nation in output of recovered sulfur. Sulfur sold or used in 1986 totaled 707,000 metric tons valued at \$79.3 million,

an increase of 25% in shipments and nearly 28% in value over that of 1985. Production of recovered sulfur from refinery and natural gases was reported by Shell Oil Co. in Clarke and Rankin Counties, Chevron U.S.A. Inc. in Jackson County, Amerada Hess Corp. in Lamar County, Pursue Gas Processing & Petrochemical Co. in Rankin County, and Koch Hydrocarbon Co. in Clarke County.

## METALS

Primary metal production, while not a significant industry in Mississippi, contributed to the economy of the State. The metal industry in Mississippi depends on out-of-State raw materials. Shipments of ferroalloys increased 9.3% while value increased 7.4%. Kerr-McGee operated an electrolytic manganese plant at Hamilton utilizing pyrolusite from West Africa. According to the Mississippi Research and Development Center, 8 companies produced gray iron castings, 6 produced steel castings, 11 produced aluminum castings, and 8 produced brass castings. There were also three secondary nonferrous smelters in Mississippi.

Birmingham Steel Corp.'s minimill in Jackson produced carbon steel bars using an electric arc furnace. It is the only minimill in the State and the largest supplier of reinforcing bar in Mississippi and Louisiana.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Birmingham News. Mississippi Economy Will Grow, But Lag Behind National Pace, Center Report Says. Nov. 30, 1986.

<sup>3</sup>Decatur (AL) Daily. Solving Port Problems. Jan. 18, 1987.

<sup>4</sup>Columbus Commercial Dispatch. Kerr-McGee Extending Operations. Dec. 9, 1986.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
United Cement Co .....	Box 185 Artesia, MS 39736	Plant .....	Lowndes.
<b>Clays:</b>			
International Minerals & Chemical Corp ..	Box 346A Aberdeen, MS 39730	Mine .....	Monroe and Tippah.
Jackson Ready Mix Concrete, a division of Delta Industries Inc.	Box 1292 Jackson, MS 39205	----do .....	Hinds.
Oil-Dri Production Co .....	Box 476 Ripley, MS 38663	Mine and plant ..	Tippah.
Presley Construction Inc .....	Box 46 Shuqualak, MS 39361	Mines .....	Noxubee.
<b>Sand and gravel:</b>			
American Sand & Gravel Co .....	Box 272 Hattiesburg, MS 39401	Stationary plant ..	Forrest.
Blain Gravel Co .....	Box 278 Mount Olive, MS 39119	Stationary plants	Clay, Copiah, Itawamba, Marion.
Hammett Gravel Co .....	Box 207 Lexington, MS 39095	Mines and plants ..	Holmes, Mar- ion, Pike.
<b>Stone (crushed, 1985):</b>			
Mississippi Stone Products .....	Box 338 Iuka, MS 38852	Quarry .....	Tishomingo.
State Department of Agriculture and Commerce.	Box 1609 Jackson, MS 39205	Quarries .....	Clay, Noxubee, Wayne.
United Cement Co .....	Box 185 Artesia, MS 39736	Quarry .....	Lowndes.



# The Mineral Industry of Missouri

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

By Leon E. Esparza,<sup>1</sup> Heyward M. Wharton,<sup>2</sup> and Ardel W. Rueff<sup>2</sup>

The value of nonfuel minerals produced in Missouri increased slightly in 1986, to \$748.6 million. The State ranked 10th in the Nation, compared with 9th in 1985. Missouri led the Nation in the production of lead; was second in lime; and third in barite, crude iron oxide pigments, and zinc.

Industrial minerals contributed 66% to the total nonfuel mineral value; cement—

Missouri's leading mineral product—accounted for almost 25% of the total. Production increases were reported for cement, copper, iron oxide pigments, lime, construction sand and gravel, and crushed stone. Lead was the leading metal produced in the State and constituted almost 21% of the total value.

Table 1.—Nonfuel mineral production in Missouri<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite----- thousand short tons--	W	W	47	\$2,791	W	W
Cement:						
Masonry-----do-----	143	\$7,033	139	6,630	167	\$7,816
Portland-----do-----	3,981	178,225	3,669	159,757	4,642	179,184
Clays <sup>2</sup> -----do-----	1,575	14,666	1,545	10,271	1,321	6,650
Copper (recoverable content of ores, etc.) metric tons--	5,818	8,575	13,410	19,797	W	W
Gem stones-----do-----	NA	<sup>e</sup> 10	NA	<sup>e</sup> 10	NA	W
Iron ore (usable) thousand long tons, gross weight--	1,370	W	1,110	W	803	W
Lead (recoverable content of ores, etc.) metric tons--	278,329	156,766	371,008	155,955	319,900	155,481
Sand and gravel:						
Construction--- thousand short tons--	7,967	19,364	<sup>e</sup> 7,500	<sup>e</sup> 20,000	9,746	24,065
Industrial-----do-----	614	8,129	535	7,330	517	6,230
Silver (recoverable content of ores, etc.) thousand troy ounces--	1,401	11,406	1,635	10,044	1,459	7,982
Stone (crushed)--- thousand short tons--	<sup>e</sup> 41,600	<sup>e</sup> 137,000	50,646	162,097	<sup>e</sup> 51,200	<sup>e</sup> 170,500
Zinc (recoverable content of ores, etc.) metric tons--	45,458	48,707	49,340	43,908	37,919	31,767
Combined value of clays (fuller's earth), iron oxide pigments (crude), lime, stone (dimension), and values indicated by symbol W --	XX	<sup>f</sup> 142,104	XX	136,370	XX	158,910
Total-----	XX	<sup>f</sup> 731,985	XX	734,960	XX	748,585

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fuller's earth; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in Missouri in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Andrew	Stone (crushed).
Audrain	Clays.
Barry	Stone (crushed).
Barton	Do.
Bates	Do.
Benton	Do.
Boone	Do.
Buchanan	Do.
Butler	Stone (crushed), clays.
Caldwell	Stone (crushed).
Callaway	Stone (crushed), clays.
Camden	Stone (crushed), stone (dimension).
Cape Girardeau	Cement, stone (crushed), clays.
Cass	Stone (crushed).
Christian	Do.
Clark	Do.
Clay	Do.
Clinton	Do.
Cole	Do.
Cooper	Do.
Crawford	Stone (crushed), clays.
Dade	Stone (crushed).
Dallas	Do.
Daviess	Do.
De Kalb	Do.
Douglas	Do.
Franklin	Stone (crushed), clays.
Gasconade	Clays, stone (crushed).
Gentry	Stone (crushed).
Greene	Stone (crushed), lime.
Grundy	Stone (crushed).
Harrison	Do.
Henry	Do.
Hickory	Do.
Holt	Do.
Howard	Do.
Howell	Do.
Iron	Lead, zinc, copper, silver, stone (crushed), stone (dimension).
Jackson	Cement, stone (crushed).
Jasper	Stone (crushed).
Jefferson	Cement, stone (crushed), sand (industrial).
Johnson	Stone (crushed).
Knox	Do.
Laclede	Do.
Lafayette	Do.
Lawrence	Do.
Lewis	Do.
Lincoln	Do.
Livingston	Clays, stone (crushed).
McDonald	Stone (crushed).
Maries	Clays.
Marion	Stone (crushed).
Mercer	Do.
Miller	Do.
Moniteau	Do.
Monroe	Stone (crushed), clays.
Montgomery	Clays, stone (crushed).
Morgan	Stone (crushed).
Newton	Do.
Nodaway	Do.
Oregon	Do.
Osage	Clays.
Perry	Stone (crushed).
Pettis	Do.
Phelps	Do.
Pike	Cement, stone (crushed), clays.
Platte	Stone (crushed), clays.
Polk	Stone (crushed).
Pulaski	Do.
Ralls	Cement, stone (crushed), clays.
Randolph	Stone (crushed).
Ray	Do.
Reynolds	Lead, zinc, copper, silver.
St. Charles	Stone (crushed), clays.
St. Francois	Stone (crushed), lime.
St. Genevieve	Lime, stone (crushed).
St. Louis	Stone (crushed), sand (industrial).
Saline	Stone (crushed).
Scotland	Do.
Scott	Do.
Shannon	Do.
Shelby	Do.
Stoddard	Clays.

See footnote at end of table.

Table 2.—Nonfuel minerals produced in Missouri in 1985, by county<sup>1</sup>—Continued

County	Minerals produced in order of value
Stone	Stone (crushed).
Sullivan	Do.
Taney	Do.
Texas	Do.
Vernon	Do.
Warren	Stone (crushed), clays.
Washington	Iron ore, lead, zinc, barite, silver, copper.
Wayne	Stone (crushed).
Webster	Do.
Worth	Do.
Wright	Do.
Undistributed <sup>2</sup>	Sand and gravel (construction), iron oxide pigments, gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Missouri business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	5,005	5,085	5,066
Total civilian labor force	do.	2,373	2,463	2,529
Unemployment	percent.	7.2	6.4	6.1
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup>	thousands	6.1	6.3	5.7
Metal mining <sup>2</sup>	do.	1.4	W	1.2
Nonmetallic minerals except fuels <sup>2</sup>	do.	2.8	3.0	3.0
Coal mining <sup>2</sup>	do.	W	W	1.5
Oil and gas extraction <sup>2</sup>	do.	W	.1	.1
Manufacturing total	do.	433.8	430.3	422.2
Primary metal industries	do.	13.7	13.3	12.6
Stone, clay, and glass products	do.	11.3	11.1	11.0
Chemicals and allied products	do.	28.6	29.3	28.1
Petroleum and coal products <sup>2</sup>	do.	1.2	1.5	1.5
Construction	do.	85.7	92.9	98.1
Transportation and public utilities	do.	136.6	139.1	140.5
Wholesale and retail trade	do.	488.5	505.7	507.9
Finance, insurance, real estate	do.	116.2	121.9	129.3
Services	do.	444.1	464.5	489.0
Government and government enterprises	do.	321.8	334.1	339.2
Total <sup>3</sup>	do.	2,032.7	2,094.7	2,131.8
<b>Personal income:</b>				
Total	millions	\$61,997	\$66,069	\$69,856
Per capita	do.	\$12,386	\$13,121	\$13,789
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do.	40.5	40.2	40.5
Total average hourly earnings, production workers	do.	\$9.3	\$9.6	\$9.8
<b>Earnings by industry:<sup>4</sup></b>				
Farm income	millions	\$556	\$811	\$755
Nonfarm	do.	\$45,325	\$48,620	\$51,494
Mining total	do.	\$317	\$375	\$358
Metal mining	do.	\$58	\$60	\$55
Nonmetallic minerals except fuels	do.	\$65	\$72	\$65
Coal mining	do.	\$102	\$108	\$103
Oil and gas extraction	do.	\$92	\$134	\$135
Manufacturing total	do.	\$10,992	\$11,595	\$11,952
Primary metal industries	do.	\$413	\$401	\$398
Stone, clay, and glass products	do.	\$289	\$293	\$309
Chemicals and allied products	do.	\$970	\$1,048	\$1,083
Petroleum and coal products	do.	\$40	\$59	\$62
Construction	do.	\$2,918	\$3,165	\$3,513
Transportation and public utilities	do.	\$4,493	\$4,677	\$4,824
Wholesale and retail trade	do.	\$7,869	\$8,414	\$8,762
Finance, insurance, real estate	do.	\$2,573	\$2,836	\$3,324
Services	do.	\$9,598	\$10,562	\$11,437
Government and government enterprises	do.	\$6,373	\$6,825	\$7,127
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>5</sup>	do.	25,017	27,236	33,208
Value of nonresidential construction <sup>5</sup>	millions	\$1,008.4	\$1,232.7	\$1,406.9
Value of State road contract awards <sup>6</sup>	do.	\$390.0	\$401.0	\$358.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,698	1,774	2,268

See footnotes at end of table.

Table 3.—Indicators of Missouri business activity —Continued

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
Nonfuel mineral production value:			
Total crude mineral value ----- millions-----	\$732.0	\$735.0	\$748.6
Value per capita -----	\$146	\$146	\$148

<sup>P</sup>Preliminary. <sup>F</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; data may not add to totals shown because of inclusion of data from other sources.

<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

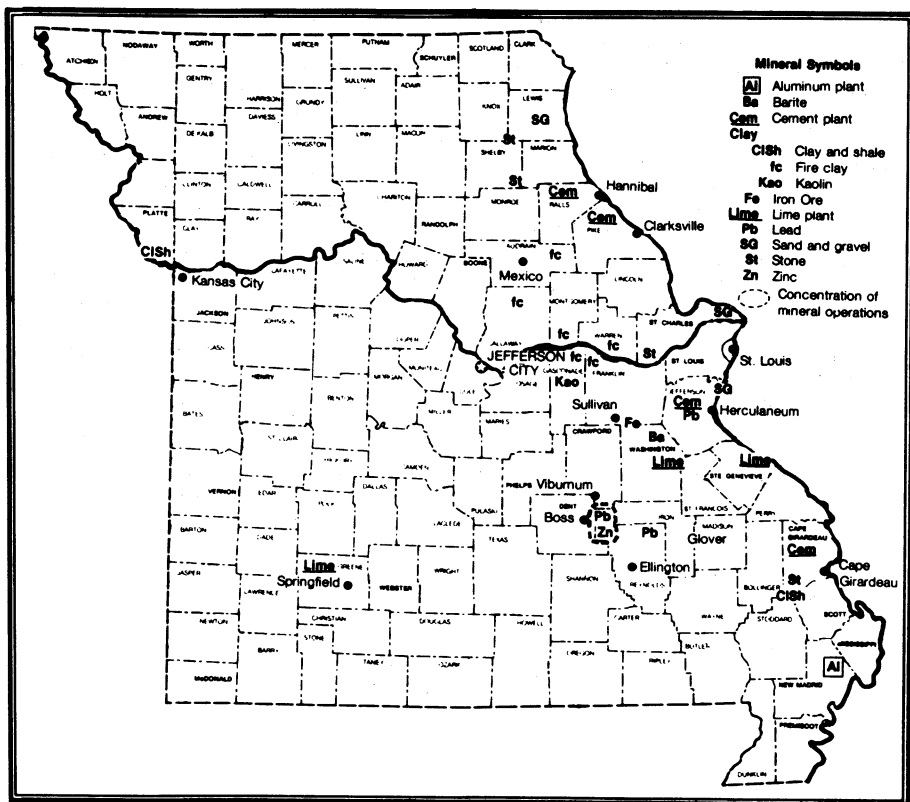


Figure 1.—Principal mineral-producing localities in Missouri.

**Trends and Developments.**—Declining interest rates had a generally positive effect on industrial minerals used in construction. These commodities accounted for two-thirds of the State's total nonfuel mineral production value, up about 6% over the 1985 figure. A total of 33,208 residential construction permits were authorized, 5,972 more than were issued in 1985. Valuation of nonresidential construction in 1986 was \$1.4 billion, a 14% increase over that of 1985.<sup>3</sup>

Lead production continued to decline in Missouri, as in other lead-producing States. Decreases were attributed to depressed lead prices during the first 5 months of the year and high producer stocks on hand at the end of 1985. Missouri's seven operating lead mines contributed about 94% of domestic lead production. One of the seven operated only about 6 months. Two large mine-mill complexes continued on standby all year. Domestic consumption decreased primarily because of a continued decline in lead used in gasoline. However, continued growth in battery systems for voltage control and emergency power backups for computers seemed certain. By yearend 1986, significant price advances were evident. This trend did not develop fast enough, however, to forestall a major corporate restructuring of the State's lead industry.

**Exploration Activities.**—Base metal exploration was dormant by yearend 1986. Falconbridge Ltd. (Canada) terminated its yearlong study of the Anschutz Mining Corp. Madison cobalt mine at Fredericktown in June. The Falconbridge study concluded that resources were insufficient to support mine development, which had been suspended by Anschutz in late 1981. The low price of cobalt, less than \$10 per pound during much of the year, may have contributed to the termination.

**Legislation and Government Programs.**—During 1986, the Missouri Department of Natural Resources (DNR), Division of Geology and Land Survey (DGLS), completed a map of mining districts and mineral occurrences in the State as part of the Midcontinent Strategic and Critical Minerals Project. DGLS continued its involvement with the U.S. Geological Survey's Conterminous United States Mineral Appraisal Program (CUSMAP). DGLS efforts on the Springfield Quadrangle for CUSMAP resulted in soon-to-be-published maps showing mines and prospects and industrial mineral resources. DGLS also continued CUSMAP work on the Harrison, Joplin,

and Paducah Quadrangles.

The U.S. Bureau of Land Management (BLM) and the U.S. Forest Service held public meetings regarding an application by USX Corp. (formerly United States Steel Corp.) and St. Joe Minerals Corp. for two preference right leases needed to continue drilling exploration for lead, zinc, and associated minerals. The leases would include 3,743 acres in the Mark Twain National Forest, south of Winona. A BLM and Forest Service joint task force was scheduled to complete a draft environmental impact statement by mid-October 1987. The area at issue was initially explored by U.S. Steel after permits were issued in November 1979. The permits were not legally renewable when they expired in November 1983. The lease application pending at yearend held up additional exploration for minable deposits.

Extractive metallurgical research by scientists and engineers at the U.S. Bureau of Mines Rolla Research Center focused on four areas related to enhanced recovery of cobalt, nickel, and other metal values from Missouri lead ore concentrates.<sup>4</sup> One study concerned base metal leach systems that could eventually replace currently used pyrometallurgical smelting processes and their attendant environmental problems.

A second study continued on technology that would allow recovery of about 2.7 million pounds of cobalt, equivalent to 13% of the Nation's annual consumption, that is lost annually from Missouri-mined copper, lead, and zinc. Tests under mill conditions recovered 70% or more of the cobalt in copper concentrate at grades of at least 3% cobalt. The study indicated that copper concentrate at grades as low as 0.25% cobalt could be used.

A third area of study involved recovery of chromium, cobalt, and nickel from mixed and contaminated superalloy scrap. Through the use of pyrometallurgical and electrometallurgical refining procedures, 90% or more of the cobalt and nickel present in superalloy scrap and wastes was recovered as electrodeposited nickel-cobalt alloy.

A fourth study sought ways to dispose of spent pickling solutions—used by stainless steel manufacturers—that contain chromium, fluoride, iron, nickel, and nitrate. The approximately 30 million gallons of spent solutions produced annually constitute major disposal problems. The recovery-recycling study was in cooperation with the



### American Iron and Steel Institute.

The Mining and Mineral Resources Research Institute of the University of Missouri—Rolla received \$587,928 from the U.S. Bureau of Mines for fiscal year 1986 under authorization of Public Law 98-409. Among the institute's objectives are basic and applied research related to the State's mineral resources for the general benefit of

the Nation's mineral industry.

The U.S. Department of Energy and the U.S. Environmental Protection Agency began a 9-year, \$357 million program to clean up the Weldon Spring site, west of St. Louis. The site had been used at various times for ordnance production and uranium enrichment.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Abrasive Materials.**—Tripoli from out-of-State sources was refined by American Tripoli Co. at its Seneca plant in Newton County. The porous, siliceous, extremely fine grains (microcrystalline) of tripoli lack distinct edges, making it useful as a mild abrasive. It is used in toothpolishing compounds and for buffing and polishing paint on automobiles.

**Barite.**—Missouri again ranked third of the four States producing barite; however, production continued to decrease. The decline was attributed mostly to the drastic downturn in drilling by the petroleum industry. Major uses of barite are as an additive to drilling muds to prevent blowouts in wells and in pigments and fillers for paint and rubber.

**Cement.**—Cement production and value increased significantly in 1986. Masonry cement increased 20% in quantity and 18% in value, and portland cement increased almost 27% in quantity and 12% in value; the average price per short ton for portland cement dropped 11%. Cement production value accounted for more than one-third of the total value of industrial minerals produced in Missouri. Five companies using seven kilns reported production of portland cement; four also reported masonry cement production. Two wet and three dry clinker-processing plants were in operation and functioned at nearly full capacity of 14,000 short tons per day. About two-thirds of the finished portland cement was sold to ready-mixed concrete companies.

**Table 4.—Missouri: Masonry cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants -	<sup>r</sup> 4	4
Production -----	139,387	159,698
Shipments from mills:		
Quantity -----	139,193	167,254
Value -----	\$6,629,930	\$7,816,278
Stocks at mills, Dec. 31 --	25,521	17,815

<sup>r</sup>Revised.

**Table 5.—Missouri: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants -	5	5
Production -----	3,882,838	4,636,359
Shipments from mills:		
Quantity -----	3,668,945	4,642,432
Value -----	\$159,757,152	\$179,183,922
Stocks at mills, Dec. 31 --	605,439	397,319

At yearend, Dundee Cement Co. and Continental Cement Co. awaited approval from various government environmental protection agencies of plans to convert their coal-powered kilns so that they can burn hazardous wastes produced in St. Louis and other midwestern cities.

**Clays.**—Total production value of clays, excluding fuller's earth, fell more than 35%. Common clay and shale, fire clay, fuller's earth, and kaolin were produced in 16 counties at 39 pits operated by 16 companies. Common clay and shale accounted for about 49% of the published value but registered a 7% decline compared with the 1985 figure. In 1986, fire clay production and value decreased about 34% compared with 1985 levels and accounted for about one-half of the total. Fuller's earth production levels and value posted moderate declines for the same period.

In late summer, USG Corp. signed a contract for the sale of its subsidiary, A. P. Green Refractories Co., to Adience Equities Inc. of Pittsburgh, PA. By yearend, however, the sale was called off because Adience was unsuccessful in securing financing for the purchase. The sales price of A. P. Green, a USG subsidiary since 1967 and the second largest company in its industry, was undisclosed. A. P. Green operates the world's largest fire clay refractory plant at Mexico, MO. USG sought a sale of A. P. Green because it no longer fit the company's plan to concentrate on building materials. According to the USG 1986 annual report to stockholders, A. P. Green, or its subsidiaries, also were among numerous defendants in about 2,000 lawsuits pending

at yearend. The litigation sought to recover compensatory and, in some cases, punitive damages for personal injury allegedly resulting from the manufacture, sale, installation, and/or removal of asbestos-containing refractory products.

Allied Chemical Corp. shut down its

Owensville fire clay (largely kaolin) calcining plant in early December. Calcining was a first step in manufacturing alumina; however, the company began using foreign bauxite that did not require calcining and was, therefore, a less expensive raw material source of alumina.

**Table 6.—Missouri: Clays<sup>1</sup> sold or used by producers**

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Kaolin		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1982	448	\$8,833	851	\$2,605	84	\$1,971	1,383	\$13,409
1983	311	5,480	1,004	3,716	103	2,652	1,418	11,848
1984	428	8,540	1,079	4,179	68	1,947	1,575	14,666
1985	284	5,073	1,205	3,497	57	1,701	<sup>2</sup> 1,545	10,271
1986	186	3,334	1,130	3,269	5	47	1,321	6,650

<sup>1</sup>Excludes fuller's earth.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Lime.**—Total lime production increased slightly compared with that of 1985. Nationally, Missouri ranked second of 34 States in lime production. Lime was produced in three counties by three companies, two of which produced both quicklime and hydrated lime. Mississippi Lime Co.'s Ste. Genevieve plant was the Nation's leading producer. Lime consumed in the State from all domestic sources totaled 174,000 short tons, a moderate decrease from 1985 consumption figures.

**Perlite (Expanded).**—Brouk Co. and Georgia-Pacific Corp. continued to expand processed perlite from out-of-State sources.

**Sand and Gravel.**—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for

even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Missouri construction sand and gravel production increased about 30% over that estimated for 1985. Production was from 46 of 114 counties by 71 companies. Counties with production in excess of 200,000 short tons are indicated in figure 1. A total of 86 pit operations—utilizing 9 stationary plants and 52 portable plants—and 24 dredging operations were reported. About two-thirds of the State's total production was from operations that produced less than 500,000 short tons. About 45% of the commodity was used for concrete aggregate.

**Table 7.—Missouri: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	4,417	\$10,997	\$2.49
Plaster and gunite sands	137	606	4.42
Concrete products (blocks, bricks, pipe, decorative, etc.)	76	175	2.30
Asphaltic concrete aggregates and other bituminous mixtures	321	872	2.72
Road base and coverings <sup>1</sup>	483	1,545	3.20
Fill	179	619	3.46
Snow and ice Control	37	106	2.86
Other <sup>2</sup>	21	80	3.81
Other unspecified <sup>3</sup>	4,075	9,066	2.22
Total or average	9,746	<sup>4</sup> 24,065	2.47

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes roofing granules.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Quantity and value of industrial sand fell about 3% and 15%, respectively, from levels reported in 1985. Three companies operated three mines in Jefferson and St. Louis Counties in east-central Missouri. The largest end use, in terms of value, was in ground fillers, followed by container fabrication and flat glass.

**Slag—Iron and Steel.**—International Mill Service Co. processed steel slag from electric furnaces at Kansas City. The material was sold for use in concrete aggregates, fill, railroad ballast, road base, and other applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Production and value of crushed stone in 1986 were estimated to have increased slightly, while dimension stone production remained unchanged.

At yearend, Missouri Limestone Inc., Warrenton, anticipated startup production of its second underground aggregate mine. The switch from open quarry to underground was made to cut costs by eliminating overburden removal and to create underground storage facilities that ultimately could serve clients within a 500-mile radius of the site.<sup>5</sup> At midyear, the Huntsville Stone Co. began development of an underground mine at its open pit quarry near Huntsville in Randolph County. In June, Neosho Construction Co. began shipping railroad ballast from its quarry near Sagnaw, Newton County. Chert ballast was produced from the quarry, which was near the Kansas City Southern Railroad.

**Vermiculite (Exfoliated).**—A significant decline in production of exfoliated vermiculite was reported for 1986.

Processed vermiculite was shipped to Brouk Co. from Virginia and South Carolina and the Transvaal region of the Republic of South Africa. The South African ore was shipped by barge up the Mississippi River to

the Brouk Co.'s exfoliation plant near St. Louis. W. R. Grace & Co. received vermiculite for exfoliation at its St. Louis plant via rail from its mines at Libby, MT, and Enoree, SC. The exfoliated material was used in insulating materials, as a soil conditioner, and as an additive in animal food.

## METALS

**Aluminum.**—Quantity and value of aluminum increased almost 7% in 1986. Early in the year, Noranda Aluminum Inc., the State's only aluminum producer, restarted one and one-half potlines, adding about 95,000 metric tons of annual primary aluminum capacity. This capacity included one 63,500-metric-ton potline idled since January 1985 and one-half of a potline idled since November 1985. The three-potline New Madrid, MO, smelter had a total capacity of 204,000 metric tons. Increased production was possible because of reduced power rates negotiated by Noranda with Associated Electric Cooperative Inc. Other factors were generally increasing aluminum prices and concessions on prices of raw materials from suppliers.

On September 1, Noranda workers at New Madrid walked off their jobs after the August 31 expiration of their contract. During the strike, production was continued, at reduced levels, by salaried employees. In early October, 350 workers returned to the potlines after Noranda and the employees union, United Steelworkers of America, agreed on a new 3-year contract. The agreement provided for reductions of \$2.49 in hourly wages and benefits.

**Copper, Lead, Silver, and Zinc.**—Missouri producers of copper, lead, silver, and zinc have a large impact on the State's economy and went through a series of significant changes during 1986. The changes were due, at least in part, to soft metal prices in 1985 and about the first half of 1986. As a result, commodity production rankings differed greatly from those of previous years.

Table 8.—Ranking of Viburnum Trend mines by nonferrous metals produced

Company	Mine name	County	Copper		Lead		Silver		Zinc	
			1985	1986	1985	1986	1985	1986	1985	1986
ASARCO Incorporated.	West Fork -----	Reynolds --	7	7	7	7	7	5	7	3
Cominco American Incorporated.	Magmont -----	Iron -----	3	2	2	1	2	2	2	1
The Doe Run Co --	Buick -----	do -----	2	6	1	2	1	1	1	2
	Casteel -----	do -----	1	1	5	5	4	6	5	6
	Fletcher -----	Reynolds --	5	3	4	3	5	4	4	4
	Viburnum No. 28	Iron -----	4	4	6	6	6	7	6	7
	Viburnum No. 29	Washington	6	5	3	4	3	3	3	5

The first change came with the announcement in mid-May by AMAX Inc. that the Buick mine-mill-smelter complex would be placed on standby. Shortly afterward, AMAX sold its 50% interest in the complex, which had the Nation's largest lead production capacity, to its partner, Homestake Mining Co. Terms of the sale included \$10 million cash and net working capital items worth about \$3 million. At yearend, the smelter complex remained on standby.

The second major change occurred in early November. Homestake Lead Co. of Missouri, a subsidiary of Homestake Mining, and St. Joe Lead Co., a division of St. Joe Minerals, formed The Doe Run Co. as a jointly managed partnership. St. Joe holds a 57.5% interest and Homestake Mining, a 42.5% interest.<sup>6</sup> Included in the agreement were Homestake Mining's Buick operations and Boss facilities. St. Joe contributed its Herculaneum lead smelter in Jefferson County and five mines and three mills in the Viburnum Trend. The consolidation left ASARCO Incorporated as the only other company with U.S. lead-smelting capacity. At yearend, Doe Run's share of the U.S. lead mining and refining industry was

about 55%.

The third change occurred in December. Asarco purchased the Milliken Mine and mill from Ozark Lead Co., a subsidiary of Kennecott. The complex was renamed the "Sweetwater Unit." Production at the mine had been halted in March 1983, and at yearend 1986 the mine remained on standby. The plant had an annual capacity of 100,000 short tons of lead and 8,000 short tons of zinc. Terms of the purchase agreement included \$850,000 cash, assumption of certain undisclosed liabilities, and payment of royalties.<sup>7</sup>

Missouri copper production and value increased significantly in 1986. The State ranked fifth of 12 producing States, unchanged from 1985, and accounted for less than 2% of the Nation's total production. Copper was recovered as a coproduct of lead-zinc mining operations at seven mines in Iron, Reynolds, and Washington Counties. Almost 60% of the State's total production came from the Casteel Mine. The State's two leading copper producers, the Casteel and Magmont Mines, were also among the Nation's 25 leading copper mines in 1986.

Table 9.—Missouri: Tenor of lead ore milled and concentrates produced in 1986

Total material	metric tons	3,335,823
Metal content of ore: <sup>1</sup>		
Copper	percent	W
Lead	do.	7.15
Zinc	do.	.98
Concentrates produced and average content:		
Copper	metric tons	W
Average copper content	percent	W
Lead	metric tons	348,047
Average lead content	percent	75.02
Zinc	metric tons	55,191
Average zinc content	percent	57.25

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Figures represent metal content of crude ore only as contained in the concentrate.

Table 10.—Production and value of lead in Missouri and the United States

Year	Missouri			United States	
	Quantity (metric tons)	Value (thousands)	Percent of U.S. production	Quantity (metric tons)	Value (thousands)
1982	474,460	\$267,150	92.6	512,516	\$288,579
1983	409,280	195,620	91.1	449,295	214,745
1984	278,329	156,766	86.3	322,677	181,745
1985	371,008	155,955	89.6	413,955	174,008
1986	319,900	155,481	94.1	339,793	165,150

**Table 11.—Missouri: Mine production (recoverable) of silver, copper, lead, and zinc**

	1984	1985	1986
Mines producing: Lode -----	7	7	7
Material sold or treated:			
Ore:			
Copper-lead ----- thousand metric tons --	--	--	1,054
Lead ----- do -----	4,749	6,434	3,336
Lead-zinc ----- do -----	--	--	705
Total ----- do -----	4,749	6,434	5,095
Production:			
Quantity:			
Silver ----- troy ounces --	1,401,070	1,635,301	1,459,185
Copper ----- metric tons --	5,818	13,410	W
Lead ----- do -----	278,329	371,008	319,900
Zinc ----- do -----	45,458	49,340	37,919
Value:			
Silver ----- thousands --	\$11,406	\$10,044	\$7,982
Copper ----- do -----	\$8,575	\$19,797	W
Lead ----- do -----	\$156,766	\$155,955	\$155,481
Zinc ----- do -----	\$48,707	\$43,908	\$31,767
Total <sup>1</sup> ----- do -----	\$225,452	\$229,705	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Data may not add to totals shown because of independent rounding.

Missouri accounted for 94% of the Nation's recoverable lead production in 1986 despite an almost 14% production decrease from that reported for the State in 1985. In addition to severely depressed lead prices for almost the first half of the year, the production decline occurred in part because of the midyear shutdown of the Buick Mine. Also, Missouri realized an overall greater share of national production owing to the midyear shutdown of the Lucky Friday silver-lead mine in Idaho because of soft metal prices.

The Magmont Mine was the Nation's leading lead producer during 1986. The mine was operated by Cominco American Incorporated but was owned equally by Cominco American and Dresser Industries Inc. Production in 1986, according to the annual report of the parent company—Cominco Ltd. of Canada—to stockholders, was 103,200 short tons of lead concentrates with an average grade of 77.0%. Concentrates from the mine were shipped to Asarco's smelter-refinery at Glover, Iron County, for processing.

Asarco completed the first full year of production at its new West Fork Mine. Lead concentrate production totaled 33,600 short tons, according to Asarco's 1986 annual report to stockholders. Asarco's smelter at Glover produced 132,500 short tons of lead bullion in 1986, up from 123,500 tons produced in 1985. This was the second consecutive year that production exceeded Asarco's

designed capacity of 105,000 short tons. The increase resulted from increased grades of feedstock and uninterrupted operations with minimal downtime for repairs and maintenance.<sup>8</sup>

Silver production was about 1,459,000 troy ounces, about 11% less than the 1985 production. Value fell to about \$7,982,000 from \$10,044,000 in 1985. Even though the Buick Mine operated less than 6 months in 1986, it continued as the State's leading silver producer.

Zinc was produced in Missouri as a co-product of lead mining operations. Production and value in 1986 dropped about 23% and 28%, respectively, primarily because the Buick Mine was placed on standby. In 1985, the Buick Mine was the State's largest and the Nation's second largest zinc operation; however, its ranking fell to second in the State and ninth nationally in 1986.

Cominco American's Magmont Mine assumed the role as the State's leading zinc producer. According to Cominco American's 1986 annual report to stockholders, zinc production totaled 11,450 short tons.

**Iron Ore.**—Pea Ridge Iron Ore Co., a subsidiary of St. Joe Minerals, produced about 803,000 long tons of usable iron ore. Production and value from the Nation's only underground iron ore mine dropped 28% and 25%, respectively. The decreases were due in large part to the loss of olivine-enriched pellet sales to Lone Star Steel Co. after the shutdown of its Daingerfield,

TX, operations. Decreased petroleum drilling activity hurt Lone Star's market for drill steel.

**Iron Oxide Pigments.**—Pea Ridge Iron was the only producer of both crude and finished iron oxide pigments in Missouri. One other company, Columbian Chemicals Co. of St. Louis, produced finished pigments. Production and value of crude pigments increased by almost 27% and 32%, respectively.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Geologist, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, MO.

<sup>3</sup>U.S. Dept. of Commerce. Construction Review. V. 33, No. 3, May-June 1987, pp. 27, 36.

<sup>4</sup>U.S. Bureau of Mines. Bureau of Mines Research 1986. Spec. Publ., 1987, pp. 51-71.

<sup>5</sup>Rukavina, M. Quarry Goes Underground. Rock Prod., v. 89, No. 9, Sept. 1986, pp. 48-51, 70.

<sup>6</sup>Homestake Mining Co. 1986 Annual Report. P. 15.

<sup>7</sup>ASARCO Incorporated. 1986 Annual Report. P. 5.

<sup>8</sup>———. 1986 Annual Report. Pp. 12-13.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum:</b>			
Noranda Aluminum Inc.-----	New Madrid, MO 63869	Plant (smelter)-----	New Madrid.
<b>Barite:</b>			
Desoto Mining Co.-----	Box 35 Richwoods, MO 63071	Mine and plant-----	Washington.
General Barite Co.-----	119 West Clement St. De Soto, MO 63020	Mines and plant-----	Do.
NL Industries Inc. Baroid Div-----	Box 2808 St. Louis, MO 63111	----do-----	Do.
<b>Cement:</b>			
Continental Cement Co.-----	Box 71 Hannibal, MO 63401	Quarry, clay, pit, plant	Ralls.
Dundee Cement Co.-----	Box 67 Clarksville, MO 63336	----do-----	Pike.
Lone Star Industries Inc.-----	Box 12449 Houston, TX 77290	Quarries and plants--	Cape Girardeau.
River Cement Co., a subsidiary of IFI International of Italy (Istituto Finanziario Industriale S.p.A.).	Box 14545 St. Louis, MO 63178	Quarry and plant---	Jefferson.
<b>Clays:</b>			
Dillon Clay Mining Co.-----	Box 115 St. James, MO 65559	Pits-----	Crawford.
A. P. Green Refractories Co., a subsidiary of USG Corp.	1018 East Breckenridge St. Mexico, MO 65265	Pits and plants-----	Audrain, Franklin, Gasconade, Maries, Osage, Stoddard.
Southern Clay Inc. (Lowe's Inc.)-----	Box 1086 Cape Girardeau, MO, 63701	----do-----	
<b>Iron ore:</b>			
Pea Ridge Iron Ore Co., a subsidiary of St. Joe Minerals Corp. <sup>1</sup>	Route 4 Sullivan, MO 63080	Underground mine and plant.	Washington.
<b>Iron oxide pigments (finished):</b>			
Columbian Chemicals Co.-----	1600 Parkwood Circle Suite 400 Atlanta, GA 30339	Plant-----	St. Louis.
<b>Lead:</b>			
ASARCO Incorporated <sup>2</sup> -----	Route 1, Box 202C Bunker, MO 63629	Underground mine and plant.	Reynolds.
Cominco American Incorporated <sup>2</sup> -----	Bixby, MO 65439	----do-----	Iron.
The Doe Run Co. <sup>2</sup> -----	11885 Lackland Rd. Suite 500 St. Louis, MO 63146	Underground mines and plants.	Iron, Reynolds, Washington.
<b>Lime:</b>			
Ash Grove Cement Co.-----	8900 Indian Creek Parkway Suite 600 Overland Park, KS 66225	Plant----- Quarries-----	Greene. Various.
Mississippi Lime Co.-----	7 Alby St. Alton, IL 62002	Quarry and plant---	Ste. Genevieve.
Resco Products of Missouri Inc., Bonne Terre Limekiln.	Box 1110 Clearfield, PA 16830	Plant-----	St. Francois.
<b>Perlite (expanded):</b>			
Brouk Co.-----	1367 South Kings- highway Blvd. St. Louis, MO 63110	----do-----	St. Louis City.
Georgia-Pacific Corp.-----	133 Peachtree St., NE. Atlanta, GA 30303	----do-----	Crawford.

See footnotes at end of table.

Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Construction:			
Holiday Sand & Gravel Co., a subsidiary of List & Clark Construction Co.	6811 West 63d. St. Overland Park, KS 66204	Dredges and plants --	Clay.
Limited Leasing Co., a subsidiary of St. Charles Sand Co.	Route 1, Box 158 Hazelwood, MO 63042	---do-----	St. Louis and St. Louis City.
Winters Bros. Material Co.-----	13098 Gravois Rd. St. Louis, MO 63127	Dredge and plant ---	St. Louis.
Industrial:			
Master Bros. Silica Sand Co., a subsidiary of Bussen Quarries Inc.	Route 1, Box 204 Pevely, MO 63070	---do-----	Jefferson.
Unimin Corp.-----	258 Elm St. New Canaan, CT 06840	Mine and plant-----	Do.
U.S. Silica Co -----	Box 187 Berkeley Springs, WV 25411	Dredge and plant ---	St. Louis.
Slag—iron and steel:			
International Mill Service Co -----	1818 Market St. Philadelphia PA 19103	Plant-----	Jackson.
Stone (crushed, 1985):			
Martin Marietta Aggregates -----	Box 30013 Raleigh, NC 27622	Quarries and plants --	Andrew, Daviess, Gentry, Harrison, Holt, Jackson, Mercer, Nodaway, Worth.
Moline Consumers Co -----	313 16th St. Moline, IL 61265	---do-----	Jefferson, Knox, Lewis, Marion, Monroe, Pike, Ralls, St. Louis, Shelby.
Tower Rock Stone Co -----	Box 69 Columbia, IL 62236	Quarry and plant ---	Ste. Genevieve.
Fred Weber Inc.-----	7929 Alabama Ave. St. Louis, MO 63111	Quarries and plants --	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co ---	13570 St. Charles Rock Rd. Bridgeton, MO 63044	---do-----	Cape Girardeau, Jefferson, St. Louis, Scott.
Vermiculite (exfoliated):			
Brouk Co.-----	1367 South Kings- highway Blvd. St. Louis, MO 63110	Plant-----	St. Louis City.
W. R. Grace & Co.-----	62 Whittemore Ave. Cambridge, MA 02140	---do-----	Do.

<sup>1</sup>Also crude iron oxide pigments.<sup>2</sup>Also copper, silver, and zinc.

# The Mineral Industry of Montana

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

By W. L. Rice,<sup>1</sup> D. C. Lawson,<sup>2</sup> and Richard B. Berg<sup>3</sup>

Montana's nonfuel mineral production value rose to \$237 million in 1986, an increase of 18% from that of 1985. A substantial rise in gold production and a marked increase in copper output were significant factors contributing to a 16% increase in the State's metallic mineral production value from the 1985 level. The largest production value gains recorded in 1986 were for copper, gold, and portland cement.

Gold was the leading commodity in terms

of value, followed by copper, silver, portland cement, and construction sand and gravel. The metals—copper, gold, iron ore, lead, molybdenum, and silver—accounted for 58% of the State's nonfuel mineral value for 1986, compared with 49% in 1985 and 60% in 1984. Montana ranked 33d in the Nation in the value of nonfuel minerals produced in 1986, up from 34th in 1985. The State ranked 39th in the value of its industrial mineral production in 1986.

Table 1.—Nonfuel mineral production in Montana<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons --	229	\$5,642	279	\$8,296	222	\$5,882
Copper (recoverable content of ores, etc.) metric tons --	W	W	15,092	22,281	W	W
Gem stones -----	NA	\$450	NA	\$400	NA	480
Gold (recoverable content of ores, etc.) troy ounces --	181,190	65,348	160,262	50,909	W	W
Lead (recoverable content of ores, etc.) metric tons --	W	W	846	356	W	W
Lime ----- thousand short tons --	89	5,097	W	W	W	W
Sand and gravel (construction) ----- do. ---	7,776	21,269	\$9,000	\$26,000	8,066	19,391
Silver (recoverable content of ores, etc.) thousand troy ounces --	5,653	46,018	4,010	24,630	4,773	26,110
Stone (crushed) --- thousand short tons --	\$950	\$2,400	\$1,730	\$5,044	\$2,200	\$26,200
Combined value of barite (1984-85), cement, graphite (1984), gypsum, iron ore (usable), molybdenum (1986), peat, phosphate rock, sand and gravel (industrial), stone (crushed traprock, 1985-86), stone (dimension), talc, vermiculite, and values indicated by symbol W -----	XX	\$93,777	XX	\$62,166	XX	178,897
Total -----	XX	\$240,001	XX	\$200,082	XX	236,960

<sup>1</sup>Estimated. <sup>2</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

<sup>3</sup>Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

<sup>2</sup>Excludes crushed traprock; value included with "Combined value" figure.



**Table 2.—Nonfuel minerals produced in Montana in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Beaverhead	Sand and gravel (industrial), peat.
Broadwater	Lime, gold, stone (crushed).
Carbon	Clays, stone (crushed).
Carter	Clays.
Cascade	Stone (crushed).
Deer Lodge	Clays.
Fergus	Gypsum, gold, silver.
Flathead	Peat.
Gallatin	Cement, stone (crushed), clays.
Granite	Silver, copper, lead, gold.
Jefferson	Gold, cement, stone (crushed), silver, clays, copper, lead.
Judith Basin	Gypsum.
Lewis and Clark	Gold.
Lincoln	Copper, silver, vermiculite, lead, gold.
Madison	Talc.
Meagher	Iron ore.
Missoula	Barite.
Park	Stone (crushed), stone (dimension), sand and gravel (industrial).
Phillips	Gold, silver, copper, lead.
Powell	Phosphate rock, gold.
Richland	Lime.
Silver Bow	Stone (crushed).
Valley	Clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—Montana Resources Inc. (MRI) resumed copper-molybdenum production at Butte in mid-July; the operation, previously owned by Anaconda Minerals Co., had been closed for 3 years. The reopening, culminating a year of planning and negotiations by MRI, was made possible by private sector and State government concessions that significantly eased the financial burden of startup. A 15% reduction in electric power rates was granted by Montana Power Co.; a Montana Department of Revenue ruling substantially reduced property taxes for 3 years; and an \$8 million loan was secured through the Montana Board of Investments. MRI's 300-person work force will receive an annual payroll of \$7.3 million, creating an estimated 640 secondary jobs in Butte. The new operation is nonunion, in sharp contrast to Anaconda Minerals' Butte operations, where labor was represented by 13 separate unions.

**Employment.**—Overall mining employment, including petroleum and coal industry workers, declined to 5,900 from the 6,800 employees reported in 1985; however, metal mining employment increased to 1,100

workers, up from the 900-employee total for 1985. Average weekly earnings for Montana's mineral industry production workers rose to \$546.06 (revised) from the \$514.24 figure recorded in 1985. Mineral industry workers were again the highest paid group in the private nonfarm industries wage sector.

**Environment.**—The 1985 proposal by the Greater Yellowstone Coalition of environmental groups, to establish a 4-million-acre Greater Yellowstone Ecosystem buffer zone surrounding Yellowstone National Park, was opposed by a resolution approved in midyear by the Western States Legislative Conference's land and energy committee. The resolution stated that the establishment of a Yellowstone ecosystem would set a dangerous precedent that could adversely affect the economies of Western States that are strongly reliant on natural resources development. The ecosystem proposal would restrict all human activities, including mining, in the federally managed buffer zone and would affect producing mines and high-potential mineralized areas in the Beaverhead, Gallatin, and Custer National Forests.

Atlantic Richfield Co., parent company of Anaconda Minerals, and its contractor, Cleveland Wrecking Co., were charged by the U.S. Environmental Protection Agency (EPA) with violation of the Clean Air Act during demolition of Anaconda Minerals copper smelter at the city of Anaconda from 1982 through 1985. EPA asked civil penalties of more than \$10 million for Cleveland's alleged failure to properly control asbestos dust during demolition and for improper disposal of asbestos-containing material. EPA's charges were being considered by a U.S. District Court at yearend.

**Exploration Activities.**—The level of exploration in Montana, largely for precious metals and industrial minerals, was up from that of 1985. In 1986, 146 companies held exploration permits for about 385 metallic and industrial mineral projects; a total of 30 new exploration licenses were issued during the year. In 1985, 110 companies held permits covering 380 projects. The number of new mining claims filed was slightly above that of 1985; by yearend, the cumulative total of Small Miners' Exclusion Statements granted was 1,127, of which 109 were issued in 1986.

Table 3.—Indicators of Montana business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands -----	824	825	819
Total civilian labor force -----	do -----	404	405	407
Unemployment -----	percent -----	7.4	7.7	8.1
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands -----	7.7	6.8	5.9
Metal mining <sup>1</sup> -----	do -----	1.1	.9	1.1
Nonmetallic minerals except fuels <sup>1</sup> -----	do -----	1.0	1.0	1.0
Coal mining <sup>1</sup> -----	do -----	1.3	1.4	1.3
Oil and gas extraction <sup>1</sup> -----	do -----	4.3	3.4	2.3
Manufacturing total -----	do -----	22.5	21.8	21.2
Primary metal industries <sup>1</sup> -----	do -----	1.5	1.4	1.2
Stone, clay, and glass products <sup>1</sup> -----	do -----	1.2	1.1	1.0
Chemicals and allied products <sup>1</sup> -----	do -----	.6	.6	.7
Petroleum and coal products <sup>1</sup> -----	do -----	.9	.9	.8
Construction -----	do -----	12.6	11.5	10.3
Transportation and public utilities -----	do -----	20.8	20.7	20.4
Wholesale and retail trade -----	do -----	75.9	74.6	72.5
Finance, insurance, real estate -----	do -----	13.4	13.3	13.0
Services -----	do -----	59.6	60.0	62.4
Government and government enterprises -----	do -----	68.7	69.9	70.4
<b>Total<sup>2</sup></b> -----	do -----	281.1	279.1	276.1
<b>Personal income:</b>				
Total -----	millions -----	\$8,915	\$9,106	\$9,666
Per capita -----	do -----	\$10,826	\$11,031	\$11,803
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do -----	39.2	39.1	39.4
Mining -----	do -----	39.4	38.6	39.3
Total average hourly earnings, production workers -----	do -----	\$10.8	\$11.0	\$11.0
Mining -----	do -----	\$12.8	\$13.4	\$13.9
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions -----	\$70	\$15	\$418
Nonfarm -----	do -----	\$5,862	\$5,969	\$5,999
Mining total -----	do -----	\$247	\$235	\$210
Metal mining -----	do -----	\$38	\$31	\$40
Nonmetallic minerals except fuels -----	do -----	\$27	\$30	\$27
Coal mining -----	do -----	\$59	\$64	\$61
Oil and gas extraction -----	do -----	\$122	\$110	\$82
Manufacturing total -----	do -----	\$559	\$551	\$546
Primary metal industries -----	do -----	\$54	\$50	\$43
Stone, clay, and glass products -----	do -----	\$29	\$27	\$27
Chemicals and allied products -----	do -----	\$17	\$18	\$19
Construction -----	do -----	\$443	\$436	\$422
Transportation and public utilities -----	do -----	\$706	\$695	\$689
Wholesale and retail trade -----	do -----	\$1,120	\$1,115	\$1,086
Finance, insurance, real estate -----	do -----	\$266	\$274	\$296
Services -----	do -----	\$1,211	\$1,297	\$1,361
Government and government enterprises -----	do -----	\$1,261	\$1,327	\$1,344
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do -----	2,897	2,034	1,153
Value of nonresidential construction <sup>4</sup> -----	millions -----	\$133.8	\$125.9	\$79.2
Value of State road contract awards <sup>5</sup> -----	do -----	\$143.9	\$201.3	\$149.6
Shipments of portland and masonry cement to and within the State -----	thousand short tons -----	254	191	242
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions -----	\$240.0	\$200.1	\$237.0
Value per capita -----	do -----	\$291	\$243	\$289

<sup>P</sup>Preliminary. <sup>T</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

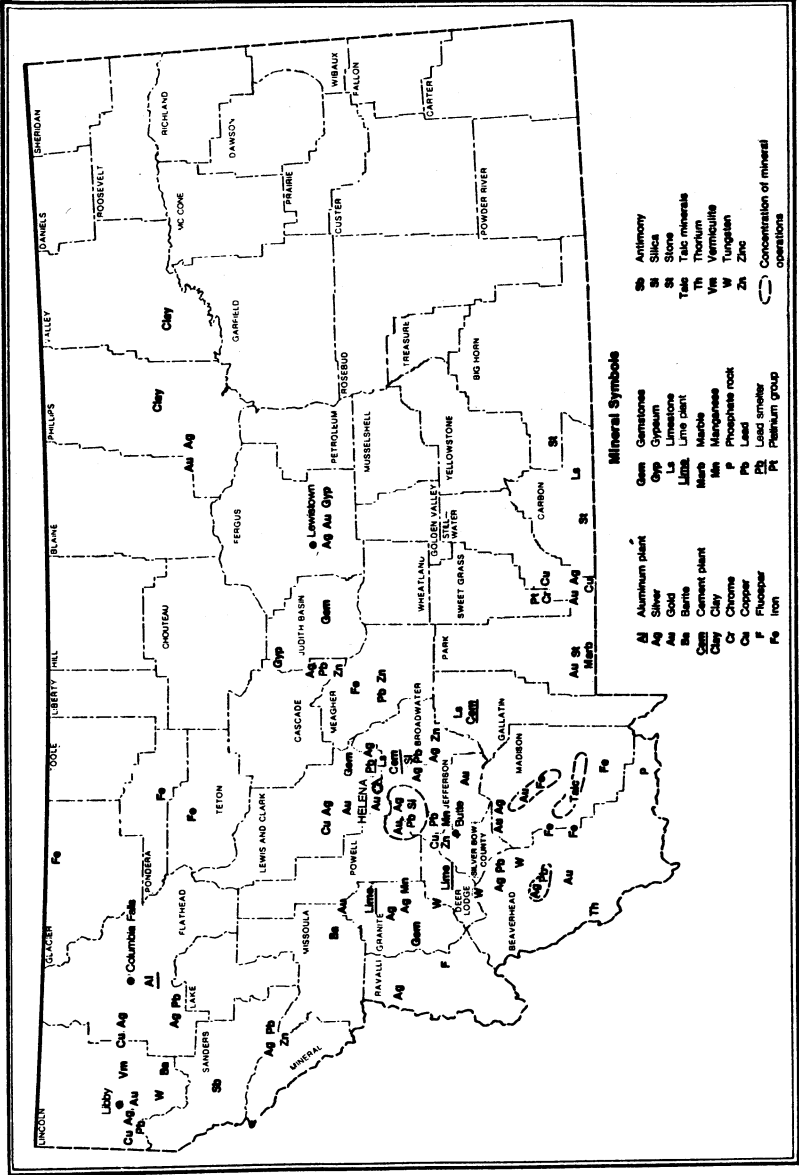


Figure 1.—Principal mineral-producing localities in Montana.

Mountain-West Resources Inc. completed an underground diamond-drilling program to test a gold-bearing pipe at its Elkhorn property in Jefferson County and signed a joint venture agreement with Homestake Mining Co. to explore and develop the property. High River Resources Ltd. completed the first of a two-phase exploration program at the Comet Mine, Jefferson County.

Gold Coin Mining Inc. continued an underground exploration program at its Gold Coin Mine, Deer Lodge County.

The AMAX Exploration Inc.-Gulf Titanium Ltd. joint venture continued drilling at the Empire Mine gold property near Marysville, Lewis and Clark County.

Moruya Gold Mines of North America Inc. started a precious metals exploration program at the Paupers Dream property in the Rimini District, Lewis and Clark County. Elsewhere near Rimini, O'Shanter Resources Inc. core drilled on the Century Silver Mines Inc. property to test a geophysical anomaly first noted in 1985.

Western Energy Co. continued precious metals exploration at its Keep Cool property near Lincoln, Lewis and Clark County, and Sunshine Mining Co. remained active at the old Blackfoot gold mine west of Lincoln.

Santa Fe Pacific Minerals Corp., the mining branch of Santa Fe Southern Pacific Corp., explored for precious metals on its claims and on leased land in the Sweetgrass Hills, Liberty County.

The Utah International Inc.-Cominco American Incorporated joint venture continued exploration for sediment-hosted massive sulfide deposits near White Sulphur Springs, Meagher County.

A late season drilling program by North Lilly Mining Co. discovered a significant high-grade gold-bearing zone in the West Vein at its Southern Cross property, Deer Lodge County.

Dillon Exploration Inc. continued exploration for talc deposits in the southern Ruby Mountains, Madison County. Western Vermiculite drilled 90 holes for a total of 10,000 feet on a vermiculite deposit near Hamilton, Ravalli County.

**Legislation and Government Programs.**—In Congress, the 1986 wilderness bill, sponsored unilaterally by Senator Melcher, proposed wilderness designation for 1.1 million acres, in addition to the 3.5 million acres already in Montana's wilderness system. The bill also called for 218,500 acres of national recreation and wildlife areas, and for a water study of 120,000 acres

in the West Big Hole; release language for the remaining 3.3 million acres of Roadless Area Review and Evaluation II land in the State was included. The bill died before yearend.

An unsuccessful 1985 proposal for a large-scale interagency land exchange, between the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service, was revived in early 1986. The plan proposed the transfer of 1.4 million acres of BLM land in western Montana to Forest Service jurisdiction, and the shifting of management responsibility for about 719,000 acres of Forest Service land in eastern Montana to the BLM. The proposed exchange, which reportedly would effect an annual savings of between \$13 and \$15 million, was opposed by the mining industry on the grounds that a change in Federal land management would destroy working relationships built up over the years. The proposal awaited enabling legislation at yearend.

Montana received \$18.97 million from the BLM in 1986 as receipts from the Mineral Leasing Act.

Mineral taxes collected by the State on nonfuel minerals, coal, oil, and natural gas amounted to \$129.4 million; mineral taxes represented 23.3% of the total Montana Department of Revenue collections for the year.

The Montana Bureau of Mines and Geology (MBMG) made progress on its Montana atlas project, aimed at replacing the 1955-dated 1:500,000-scale State geologic map with 26 full-color, detailed geologic maps at a scale of 1:250,000.

During the year, MBMG accelerated work on a computerized data base for metallic mineral resources for the State. Other significant projects included geochemical assessment and geologic mapping of both the Elkhorn Mountains Volcanics (associated with the Emery Mining District near Deer Lodge) and the Lowland Creek Volcanics near Butte (which are the host for extensive mineral deposits between Butte and Helena) and a report on barite deposits. The MBMG released 7 formal publications and placed 14 titles on open file during fiscal year 1986, and the ongoing MBMG-U.S. Geological Survey hydrologic program worked on 5 project areas during 1986.

The Mining and Mineral Resources Research Institute at the Montana College of Mineral Science and Technology, at Butte, received funding totaling \$185,207 from the U.S. Bureau of Mines in fiscal year 1986. The institute has received a total of \$2.2 million since inception of the program in 1978.

**REVIEW BY NONFUEL MINERAL COMMODITIES****METALS**

**Aluminum.**—The Columbia Falls Aluminum Co. (COFAC) operated its reduction plant in Flathead County at the annual rated capacity of 180,000 short tons of metal. In midyear, the company signed an agreement with the Bonneville Power Administration that guaranteed a variable electric power rate tied to the price of aluminum. In August, COFAC signed 3-year tolling contracts with The Broken Hill Pty. Co. Ltd. and Norsk Hydro A/S; the contracts, covering 100% of the plant's capacity, assure continued operation into 1988.

**Antimony.**—United States Antimony Corp. produced antimony oxide at its refinery near Thompson Falls, Sanders County, using antimony sulfide concentrates purchased on contract from China. At yearend, construction was under way on a plant to produce high-purity sodium antimonate for glass manufacture.

**Copper.**—Reflecting the midyear return of Butte copper operations to production, the quantity and value of Montana's copper production more than doubled from the numbers recorded in 1985. Copper production was reported from three mines in three counties in 1986, compared with output from five mines in four counties in 1985. Montana ranked fourth in the Nation in copper production in 1986, the same ranking achieved in both 1984 and 1985.

The State's copper producers were MRI's Butte operations in Silver Bow County, ASARCO Incorporated's Troy silver-copper mine in Lincoln County, and Black Pine Mining Co.'s Black Pine Mine near Philipsburg, Granite County.

In mid-July, MRI commenced large-scale mining in Butte at its Continental Pit operation; by the end of August, the full-

scale production goal of 40,000 short tons of ore per day had been met. The first 2,000-ton shipment of copper concentrates was made in late August; concentrates went by rail to Vancouver, WA, and onward by barge to smelters in Japan and the Republic of Korea.

**Gold.**—Montana's gold production increased significantly in both quantity and value from that of 1985; the State again ranked fourth in the Nation for gold production. Production was reported from nine lode mines in seven counties, compared with production from seven mines in five counties in 1985.

According to the company's 1986 annual report, gold production from Placer U.S. Inc.'s Golden Sunlight Mine near Whitehall, Jefferson County, decreased to about 92,400 troy ounces from the 96,200 (revised) ounces recovered in 1985. The mill throughput was moderately increased from about 2.2 million short tons in 1985 to approximately 2.3 million tons, to offset a slightly lower average ore grade and a reduced recovery. Mill recovery was 77.62%, compared with the 79.5% recovery rate achieved in 1985. Ore reserves at yearend were 17.5 million tons, grading 0.047 ounce of gold per ton. A new sand tailing retreatment plant, designed to recover additional gold values lost to tailings, was installed and put on-line by yearend, and a preaeration process to reduce reagent consumption was added to the mill. An underground diamond-drilling program completed in the West Mineral Hill area adjacent to the current operation indicated a potential 20-million-ton ore body grading 0.06 ounce of gold per ton. The Golden Sunlight Mine was Montana's first-ranked gold producer in 1986.

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

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (metric tons)	Gold		Silver		
	Lode	Placer		Troy ounces	Value	Troy ounces	Value	
1984, total	16	2	10,084,174	181,190	\$65,347,626	5,652,847	\$46,017,907	
1985, total	7	6	9,445,713	160,262	50,908,666	4,009,979	24,630,092	
1986:								
Broadwater	1	1	14,515	W	W	718	3,927	
Cascade	1	--	2,451	1,486	547,205	4,830	26,420	
Granite	1	--	W	W	W	W	W	
Jefferson	3	2	W	W	W	W	W	
Lincoln	1	--	2,881,534	405	149,137	4,075,182	22,291,246	
Madison	1	--	26,060	16	5,892	114	624	
Meagher	--	1	W	W	W	W	W	
Phillips	1	--	W	W	W	W	W	
Powell	--	2	W	W	W	W	W	
Silver Bow	1	--	W	--	--	W	W	
Total	10	6	<sup>3</sup> 14,997,087	W	W	<sup>3</sup> 4,773,264	<sup>3</sup> 26,109,755	
				Copper		Lead		Zinc
				Metric tons	Value	Metric tons	Value	Metric tons
1984, total				W	W	W	W	--
1985, total				15,092	\$22,280,514	846	\$355,668	--
1986:								W
Broadwater	--	--	--	--	--	--	--	573,625
Cascade	--	--	--	--	--	--	--	W
Granite	W	W	W	W	W	--	--	W
Jefferson	--	--	--	--	--	--	--	47,289,037
Lincoln	16,889	24,594,029	421	204,625	--	--	--	6,516
Madison	--	--	--	--	--	--	--	W
Meagher	--	--	--	--	--	--	--	W
Phillips	--	--	--	--	--	--	--	W
Powell	--	--	--	--	--	--	--	W
Silver Bow	W	W	--	--	--	--	--	W
Total	W	W	W	W	--	--	--	<sup>3</sup> 190,341,439

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Operations from which gold and silver are recovered as byproducts from sand and gravel operations are not counted as producing mines.<sup>2</sup>Excludes gravel washed.<sup>3</sup>Includes items indicated by symbol W.

Table 5.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation	W	W	--	W	--
Smelting of concentrates from ore	W	4,450,065	W	W	--
Direct smelting of ore	W	W	W	W	--
Total lode material	W	<sup>1</sup> 4,773,264	W	W	--
Placer	W	--	--	--	--
Grand total	W	4,773,264	W	W	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes items indicated by symbol W.

**Production** in 1986 at Pegasus Gold Inc.'s Zortman-Landusky seasonal open pit heap-leach operation in the Little Rockies, Phillips County, increased to about 86,300 ounces of gold and 214,700 ounces of silver, up from the 60,400 ounces of gold and 157,500 ounces of silver recorded in 1985, according to the company's annual report. Although torrential rainfall in late September caused abnormally high leach solution volumes, record production was achieved, with more than 6.5 million tons of ore loaded on the leach pads in 1986. Ore reserves at yearend were 36 million tons, grading 0.019 ounce of gold per ton; more than 400,000 ounces of gold had been recovered from 29 million tons of ore mined since startup in 1979. The Zortman-Landusky operation ranked second in the State in gold production in 1986.

Construction and mine development at Pegasus Gold's Montana Tunnels project near Wickes, Jefferson County, were ahead of schedule in 1986, with production slated for early April 1987. About 4.2 million tons of preproduction stripping was done, including stockpiling 130,000 tons of ore. Concentrator equipment was installed, and all ancillary systems, including tailings disposal, were completed. Allowing for a 3-month startup phase, the mine is expected to produce 50,000 ounces of gold, 700,000 ounces of silver, 13,000 short tons of zinc, and 3,000 short tons of lead in 1987. Lead-silver concentrates, amounting to 11,000 tons per year, will be trucked to Asarco's East Helena, MT, smelter. Capital costs, originally estimated at \$57.5 million, were reduced to \$51.5 million, including \$4.4 million working capital. The operation will employ 230 workers when full production is achieved.

The Jardine joint venture project of Homestake Mining and American Copper & Nickel Co. Inc. received the necessary State operating permits in September for its proposed 750-ton-per-day underground gold mine at Jardine, Park County. Activity in 1986 was confined to underground exploration and development; a production decision is expected to be made in 1987.

Western Energy, the mining subsidiary of Montana Power, continued detailed exploration and the permitting process at its Chartam gold project near Winston, Broadwater County. By yearend, a 9-million-ton ore reserve, grading 0.04 ounce of gold per ton, had been drilled out. Western Energy's proposed open pit mine would operate on a

year-round schedule; the heap-leach facility would operate for two 45-day leach cycles during the warm-weather months. The company plans to commence construction when all permits are in hand; this is anticipated to be by midsummer 1987.

Cimarron Exploration Inc. worked on mill design and underground development at its Spotted Horse Mine, Fergus County. Startup of the mine and 50-ton-per-day combined vat-leach and flotation mill is projected for spring 1987. Initial production will be from high-grade ore averaging 1 ounce of gold per ton.

Placer gold production, which increased markedly from that recorded in 1985, was reported from six operations in Broadwater, Jefferson, Meagher, and Powell Counties. Stream gravel, bench gravel, and ancient riverbed placer deposits were worked by small-scale mechanical and hand methods, and by dragline dredging.

**Iron Ore.**—Hallet Minerals Co. produced iron ore from the Black Butte Mine near White Sulphur Springs, Meagher County. The iron ore was used instate in the manufacture of cement.

**Lead.**—Lead was recovered as a byproduct from two base and precious metal mines in two counties. Asarco's 75,000-short-ton-per-year-capacity lead bullion smelter at East Helena curtailed operations in April, owing primarily to the closure of the Lucky Friday silver-lead mine at Mullan, ID. The smelter operated on a 5-day-per-week schedule until August, when the normal 7-day schedule was resumed; smelter output for 1986 was 50,800 tons of lead bullion.

**Molybdenum.**—The State's first molybdenum output since 1983 was produced in 1986 as byproduct from MRI's Butte copper operation, which started in midyear. Molybdenum concentrates were shipped to markets in Belgium and Chile.

**Platinum-Palladium.**—The Stillwater Mining Co. (SMC), a joint venture of Lac Minerals Ltd., Chevron Resources Co., and Manville Corp., started construction on a 500-short-ton-per-day concentrator and support facilities at its platinum-palladium mine near Nye, Stillwater County.

SMC completed its permitting in January, and in August it finished a 12-month test mining program that confirmed ore grades, evaluated mining methods, and developed two new working levels in the mine. Production is slated to start in April 1987, at an initial rate of 500 tons per day, and is

expected to yield about 25,000 troy ounces of platinum and 75,000 ounces of palladium annually. The company plans to double the initial production rate by 1992; projected mine life is 20 to 30 years.

**Silver.**—The quantity of Montana's silver production increased, despite depressed silver prices prevalent during the year; the value of silver production increased slightly from the level achieved in 1985. The State produced nearly 14% of the Nation's silver and advanced to the third ranking in silver production. Silver production was reported from 10 mines in 8 counties, compared with production from 7 mines in 5 counties in 1985.

Asarco's Troy silver-copper mine, Lincoln County, was Montana's top silver producer and the first-ranked silver-producing mine in the Nation. Asarco reported that nearly 4.1 million troy ounces of silver in concentrate was produced at the Troy Mine, compared with 3.6 million troy ounces in 1985.

Production at Black Pine Mining's Black Pine silver-copper mine near Philipsburg, Granite County, continued at a reduced rate during most of the year. In April, mining of sulfide ore was discontinued, and near-surface oxidized silver ore was mined for the remainder of the year. The ore was beneficiated in the only heavy-media separation plant in Montana, and concentrates were shipped to Asarco's East Helena smelter. The Black Pine Mine was again the State's second-ranked silver producer; Pegasus Gold's Zortman-Landusky gold mine ranked third.

Asarco proceeded with patent applications on mining claims covering its Rock Creek stratabound silver-copper deposit in the Cabinet Mountains Wilderness, Lincoln County. Baseline environmental studies were completed, and work commenced on an operating permit application.

The U.S. Forest Service upheld the right of United States Borax & Chemical Corp. to further explore its mining claims in the Rock Lake area of the Cabinet Mountains Wilderness. In 1986, U.S. Borax surface-drank the Rock Lake stratabound silver-copper deposit to more precisely determine grade, location, and attitude of the deposit in preparation for underground work in 1987-88. The company reported that surface drilling had developed 97 million short tons of demonstrated and inferred ore grading 0.9% copper and 1.9 ounces of silver per ton. A conceptual mining plan calls for under-

ground mining accessed by adits outside the wilderness boundary. Crude ore production would be 3 million tons per year, yielding more than 5.1 million ounces of silver and 24,000 short tons of copper per year. Capital expenditure would be in excess of \$100 million; 300 to 350 workers would be employed, with an annual payroll of about \$10 million. Mine life is projected to be at least 20 years. Production would follow a 5- to 9-year predevelopment, permitting, and development period.

## INDUSTRIAL MINERALS

**Barite.**—Montana Barite Co. Inc., a subsidiary of NICOR Mineral Ventures Inc., sold barite from its plant in Missoula but did not operate its barite mines during 1986. The barite market in Montana was severely limited during the year, owing to the low level of oil and gas well drilling in the market area.

**Cement.**—Montana's cement production was up 41% in quantity and 30% in value from the levels reported in 1985. Portland and masonry cements were produced by Ideal Basic Industries Inc. at Trident, Gallatin County, and by Kaiser Cement Corp. at Montana City, Jefferson County. Portland cement produced in the State was used by ready-mixed concrete companies (73%), other contractors (11%), concrete product manufacturers (7%), highway contractors (5%), building material dealers (2%), and government agencies and miscellaneous customers (2%). Raw materials consumed in cement manufacture were locally mined cement rock, clay, gypsum, iron ore, limestone, sand, sandstone, and slag. Both of the one-kiln, wet-process plants used natural gas and coal for fuel and purchased electricity for energy.

**Chlorite.**—Cyprus Industrial Minerals Co. mined chlorite at the Golden Antler Mine near Silver Star, Madison County; the chlorite was sold for many of the same industrial applications for which talc was used. Claims were staked by an individual on a newly discovered chlorite deposit in the southern Highland Mountains west of Silver Star.

**Clays.**—The aggregated production for all varieties of clay in the State decreased 21% in quantity and 29% in value from the 1985 totals. Montana ranked third nationally in bentonite output, although production decreased 28% in quantity and nearly 30% in value from that achieved in 1985. The significant decrease in production of swell-



ing bentonite was attributed largely to oil curtailed and gas well drilling activity in the regional marketing area. Bentonite production was reported by 4 companies from 10 deposits in Carbon, Carter, and Valley Counties.

American Colloid Co. produced bentonite in early 1986 but commenced dismantling its plant at Malta late in the year. AIMCOR and NL Industries Inc., Baroid Div., mined bentonite from deposits in Carter County.

Most of the State's bentonite production was sold for drilling mud, iron ore pellet binder, and foundry sand.

Common clay, produced by four companies from four pits in Gallatin and Jefferson Counties, was used in portland cement, concrete blocks, and pottery.

**Gem Stones.**—The State ranked fifth nationally in natural gem stone production. Vortex Mining Co. at Utica, Judith Basin County, completed a sapphire-washing plant on a western extension of the Yogo dike; most of the sapphires recovered by Vortex were the highly prized cornflower-blue color. The sapphires were cut either by Vortex or by lapidarists in Thailand; no rough material was offered for sale. Roncor Inc. purchased Intergem Inc.'s Yogo Sapphire Mine on the main Yogo dike and produced sapphires during the year. Sapphires also were produced from the Rock Creek District, Granite County. Montana Gold and Sapphires Inc. finished construction of a new dredge and recovered placer gold and sapphires from the Missouri River below Canyon Ferry Dam, Lewis and Clark County. Smoky quartz was mined from claims in Missoula County, and amethyst was produced in Beaverhead and Jefferson Counties.

**Gypsum.**—Gypsum production in Montana increased by about 6% in quantity, but the value dropped by nearly 13% from that reported in 1985. USG Corp. mined gypsum from its underground Shoemaker Mine at Heath, Fergus County; the gypsum was calcined and processed locally in the company's wallboard plant. Maronick Construction Co. Inc. began mining gypsum at a new open pit operation at Raynesford, Judith Basin County. The product was shipped to the Kaiser Cement plant at Montana City and to the Ideal Basic Industries cement plant at Trident.

**Lime.**—Lime production in the State increased by almost 58% in quantity and 40% in value from that achieved in 1985. Continental Lime Inc., Holly Sugar Corp., and Great Western Sugar Co. produced quick-

lime in Broadwater, Richland, and Yellowstone Counties, respectively. Great Western also produced a small tonnage of hydrated lime.

**Peat.**—Peat production in 1986 decreased significantly in quantity and value from that of 1985. Peat produced by Martins Peat Inc. at Swan Lake, Flathead County, was dried and marketed in packaged form. The company was the State's only peat producer in 1986.

**Phosphate Rock.**—Phosphate rock production decreased about 9% in quantity and 24% in value from the 1985 levels. The State's sole producer, Cominco, continued to mine phosphate rock at its underground Warm Springs Mine near Garrison, Powell County. After primary crushing, the phosphate was rail shipped to Cominco's fertilizer plant at Kimberly, British Columbia, Canada. The Warm Springs Mine suspended operations indefinitely in November in response to a shutdown at the fertilizer plant.

Stauffer Chemical Co. laid off 35 workers in April at its Silver Bow elemental phosphorus plant, which produced about 35,000 short tons of phosphorus annually for consumption in fertilizers, food phosphates, fire retardants, and other applications. The lay-off, the second in 3 years, was effected to reduce stockpiled phosphorus inventories accumulated owing to declining markets.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The 1986 output of construction sand and gravel in Montana increased by nearly 4% in quantity but decreased by almost 9% in value from that reported for 1984, when the last complete canvass was taken. The largest unit value decreases were recorded for the concrete aggregate, asphaltic concrete aggregate, and road base and coverings end-use categories.

In 1986, six counties—Cascade, Dawson, Flathead, Gallatin, Sheridan, and Yellowstone—accounted for slightly more than 56% of the State's total construction sand and gravel tonnage. Major uses were for unspecified applications (35%), road base and coverings (32%), asphaltic concrete aggregates (18%), and concrete aggregates (9%). The bulk of the construction sand and gravel was transported by truck.

Table 6.—Montana: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	746	\$2,685	\$3.60
Plaster and gunitite sands -----	W	W	2.80
Asphaltic concrete aggregates and other bituminous mixtures -----	1,455	3,903	2.68
Road base and coverings <sup>1</sup> -----	2,542	4,704	1.85
Fill -----	324	845	2.61
Snow and ice control -----	42	72	1.71
Railroad ballast -----	W	W	2.00
Other -----	134	304	2.27
Other unspecified <sup>2</sup> -----	2,824	6,878	2.44
Total or average -----	<sup>3</sup> 8,066	19,391	2.40

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

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Industrial sand and gravel production was reported by Stauffer Chemical, from Maiden Rock, Beaverhead County; the product was used as flux at the company's Silver Bow elemental phosphorus plant.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Estimated 1986 crushed stone production increased nearly 28% in quantity and slightly more than 23% in value from that reported in 1985. Increased activity in highway and secondary road construction and maintenance contributed significantly to the increase.

**Dimension.**—Dimension building stone was produced by the Livingston Marble & Granite Works from quarries north of Gardiner, Park County, and marketed from its plant at Livingston.

**Sulfur (Recovered).**—Montana Sulphur & Chemical Co. and Farmers Union Central Exchange recovered sulfur as a byproduct from petroleum refining at Laurel, Yellowstone County. The quantity of sulfur produced increased 10% and the value rose by nearly 12% from that reported in 1985.

**Talc.**—Montana retained first ranking in the Nation for the quantity and value of its talc production; production increased about 14% in quantity and nearly 10% in value over that reported in 1985. Nearly all of the State's talc production came from open pit mines in the Ruby, Gravelly, and Greenhorn Ranges in Madison County. In December, Cyprus Industrial began to mine talc underground at its Beaverhead Mine. Cy-

prus Industrial also operated the Yellowstone open pit mine and processed the ore at its Three Forks mill in Gallatin County. Pfizer Inc. operated the Treasure Chest Mine and embarked upon a major stripping program at the property; by yearend, 5.8 million short tons of waste rock had been removed. Pfizer processed the Treasure Chest ore at its Barretts mill south of Dillon, Beaverhead County.

Montana Talc Co., a 50-50 joint venture between NICOR Mineral Ventures and Meridian Minerals Co., began production in midyear. Talc was mined at the company's Johnny Gulch open pit mine south of Ennis in Madison County and trucked 53 miles north to its 100,000-ton-per-year talc mill at Sappington, Gallatin County. The \$12 million operation employed a 50-member work force and had reserves of 95% pure talc sufficient for 11 years of operation. Willow Creek Talc Inc. recommenced mining in May at its Willow Creek Mine; the mine had been inactive since 1979. Talc milled in Montana in 1986 was used in paper (25%), paint (15%), ceramics (7%), plastics (6%), cosmetics (4%), and other applications, including rubber, refractories, roofing, and miscellaneous (43%).

Exploration activity for talc continued in the Precambrian areas of southwestern Montana by the producing companies and others.

**Vermiculite.**—Montana again led the Nation in vermiculite production. The 1986 production was nearly 92% of the yearly average for the 5-year period (1982-86); the value of production was about 99% of the yearly average for the 5-year period. W. R. Grace & Co. mined and milled vermiculite at the Rainy Creek operation near Libby,

Lincoln County, and started the patent process on a block of new mining claims that would add substantially to ore reserves at the Rainy Mine.

Robinson Insulation Co. at Great Falls, Cascade County, produced exfoliated vermiculite, which was sold for block insulation, loose fill insulation, agricultural soil

conditioner, concrete aggregate, horticultural applications, and fireproofing material.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Spokane, WA.

<sup>2</sup>Staff field agent, Montana Bureau of Mines and Geology, Butte, MT.

<sup>3</sup>Geologist, Montana Bureau of Mines and Geology, Butte, MT.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum:</b>			
Columbia Falls Aluminum Co. ----	Columbia Falls, MT 59912	Reduction plant -----	Flathead.
<b>Cement:</b>			
Ideal Basic Industries Inc., Cement Div. -----	Box 8789 Denver, CO 80201	Plant -----	Gallatin.
Kaiser Cement Corp. -----	Montana City, MT 59602	----do-----	Jefferson.
<b>Clays:</b>			
AIMCOR -----	Box 460 Belle Fourche, SD 57717	Pits -----	Carter.
American Colloid Co. -----	5100 Suffield Ct. Skokie, IL 60078	Pit and plant -----	Carbon and Phillips.
M-I Drilling Fluids Co. -----	117 Fifth Ave. Belle Fourche, SD 57717	----do-----	Valley.
NL Industries Inc., Baroid Div. ----	Box 1675 Houston, TX 77251	----do-----	Carter.
<b>Copper:</b>			
ASARCO Incorporated -----	Box 868 Troy, MT 59935	Underground mine and plant.	Lincoln.
Montana Resources Inc. -----	600 Shields Ave. Butte, MT 59701	Surface mine and plant --	Silver Bow.
<b>Gem stones:</b>			
Montana Gold and Sapphire Inc. ---	Box 155 Helena, MT 59624	Dredge -----	Lewis and Clark.
Roncor Inc. -----	2056 South Burrington Ave. Los Angeles, CA 90025	Open pit mine and plant	Judith Basin.
<b>Gold:</b>			
Golden Sunlight Mines Inc., a subsidiary of Placer U.S. Inc. -----	Box 678 Whitehall, MT 59759	----do-----	Jefferson.
Pegasus Gold Inc. -----	Zortman, MT 59546	Open pit mines and leach plant.	Phillips.
<b>Gypsum:</b>			
Maronick Construction Co. Inc. ---	East Helena, MT 59635	Open pit mine -----	Judith Basin.
USG Corp. -----	Heath, MT 59457	Underground mine and plant.	Fergus.
<b>Lime:</b>			
Continental Lime Inc. -----	268 West 400 South Suite 201 Salt Lake City, UT 84101	Open pit mine -----	Broadwater.
Great Western Sugar Co. -----	3020 State Ave. Box 30878 Billings, MT 59107	Surface mine and plant.	Yellowstone.
Holly Sugar Corp. -----	Box 1052 Colorado Springs, CO 80901	----do-----	Richland.
<b>Phosphate rock:</b>			
Cominco American Incorporated --	Box 638 Garrison, MT 59731	Underground mine ---	Powell.
<b>Sand and gravel:</b>			
Baltrush Construction Co. -----	Box 111 Havre, MT 59501	Pit -----	Hill.
Fike Crushing -----	525 Harvey Ave. Harvey, ND 58341	Pit -----	Sheridan.
Fisher Sand & Gravel Co. -----	Box 1034 Dickinson, ND 58601	Pits -----	Richland and Dawson.
Konitz Contracting Inc. -----	Box 595 Lewiston, MT 59547	Pit -----	Fergus.
Schellinger Construction Co. Inc. ---	Box 517 Columbia Falls, MT 59912	Pits -----	Flathead.
Sletten Construction Co. -----	Box 2467 Great Falls, MT 59403	----do-----	Various.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Silver:			
ASARCO Incorporated -----	Box 868 Troy, MT 59935	Underground mine and plant.	Lincoln.
Black Pine Mining Co -----	Box 610 Phillipsburg, MT 59858	Underground mine ---	Granite.
Stone (dimension):			
Livingston Marble & Granite Works.	Box 851 Livingston, MT 59047	Quarries and plant. ---	Park.
Sulfur (recovered):			
Montana Sulphur & Chemical Co ---	Box 31118 Billings, MT 59107	Plant -----	Yellowstone.
Talc:			
Cyprus Industrial Minerals Co ---	Box 3299 7000 South Yosemite Englewood, CO 80155	Plant, open pit and un- derground mines.	Gallatin and Madison.
Montana Talc Co -----	28789 Sappington Rd. Three Forks, MT 59752	Plant and open pit mine	Do.
Pfizer Inc -----	Box 1147 Dillon, MT 59725	---do -----	Beaverhead and Madison.
Willow Creek Talc Inc. -----	Box 5 Alder, MT 59710	Open pit mine -----	Madison.
Vermiculite:			
W. R. Grace & Co., Zonolite Div ---	1114 Avenue of the Americas New York, NY 10036	Open pit mine and plant	Lincoln.



# The Mineral Industry of Nebraska

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

By Leon E. Esparza<sup>1</sup> and Raymond R. Burchett<sup>2</sup>

Value of nonfuel mineral production in Nebraska in 1986 fell to about \$94.1 million, 6% below that of 1985. Production value dropped for six of the eight commodities produced in Nebraska. The value of industrial sand posted the largest percentage decline, followed in order by construction sand and gravel, masonry cement, clays, crushed stone, and portland cement. Lime, the only commodity to record an increase in value, accounted for only a small fraction of the total value of minerals produced. Gem

stone production value was about the same as estimated for 1985. Nebraska ranked 41st in the Nation for value of nonfuel mineral production.

Most of the State's nonfuel mineral production is used in construction. A total of 6,236 residential units were authorized in 1986, 1,235 permits more than were issued in 1985. Valuation of nonresidential construction in 1986 was \$247 million, a decrease of about 14% from that of 1985.

Table 1.—Nonfuel mineral production in Nebraska<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons ..	180	\$556	244	\$718	221	\$668
Gem stones .....	NA	W	NA	*10	NA	10
Sand and gravel (construction) thousand short tons ..	11,839	27,791	*11,600	*28,800	9,675	23,912
Stone (crushed) ----- do. ....	*4,500	*23,400	4,175	19,134	*4,000	*17,900
Combined value of cement, lime, sand and gravel (industrial), and value indicated by symbol W .....	XX	48,621	XX	51,308	XX	51,598
Total .....	XX	100,368	XX	99,970	XX	94,088

<sup>1</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

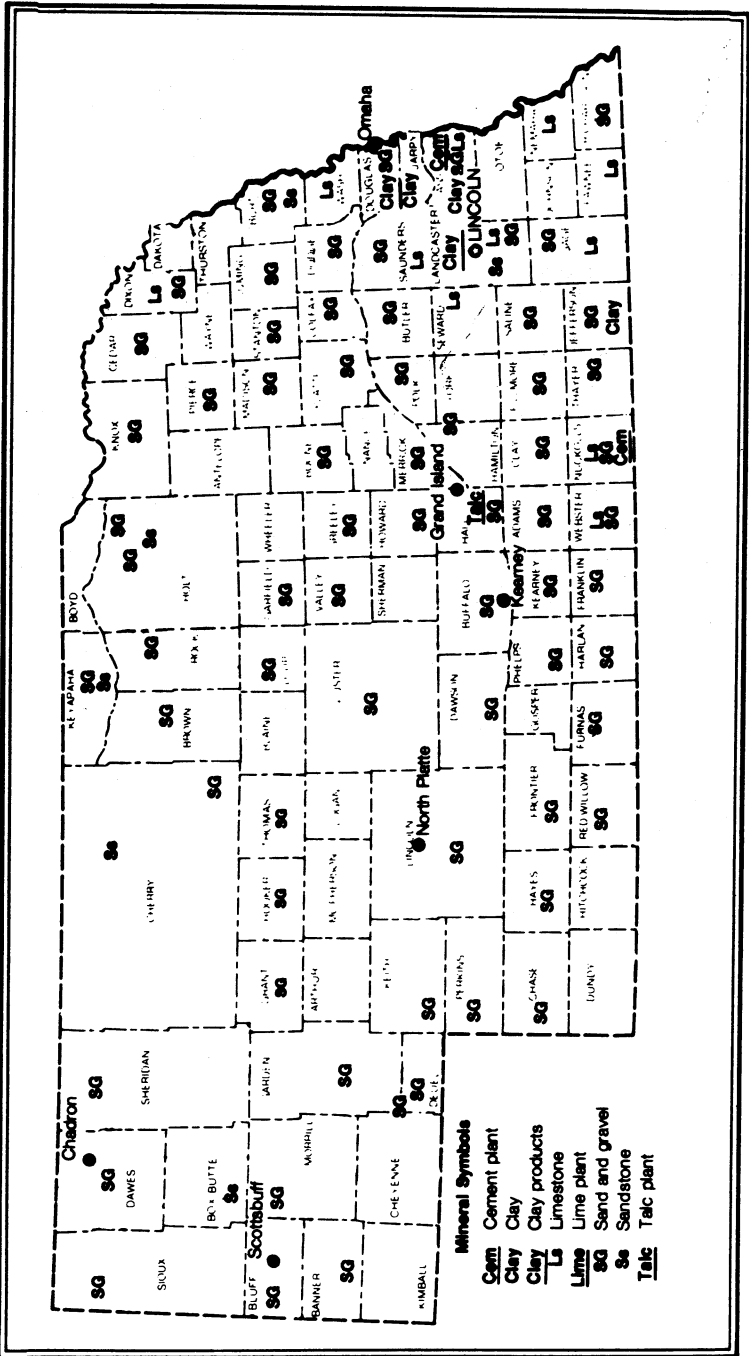


Figure 1.—Principal mineral-producing localities in Nebraska.

Table 2.—Nonfuel minerals produced in Nebraska in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Cass	Cement, stone (crushed), clays.
Dixon	Stone (crushed).
Douglas	Clays.
Gage	Stone (crushed).
Jefferson	Clays.
Lancaster	Stone (crushed), clays.
Morrill	Lime.
Nuckolls	Cement, stone (crushed).
Pawnee	Stone (crushed).
Sarpy	Clays.
Saunders	Stone (crushed), sand (industrial).
Scotts Bluff	Lime.
Seward	Stone (crushed).
Washington	Do.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Nebraska business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	1,605	1,605	1,598
Total civilian labor force	do.	796	804	803
Unemployment	percent.	4.4	5.5	5.0
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup>	thousands	1.9	1.9	1.9
Nonmetallic minerals except fuels <sup>1</sup>	do.	1.0	1.1	1.1
Manufacturing total	do.	90.5	88.4	85.8
Stone, clay, and glass products <sup>4</sup>	do.	2.5	2.6	2.6
Chemicals and allied products	do.	2.6	2.7	2.6
Construction	do.	25.8	26.1	24.7
Transportation and public utilities	do.	43.2	43.9	42.9
Wholesale and retail trade	do.	163.6	169.0	168.7
Finance, insurance, real estate	do.	43.4	45.4	47.1
Services	do.	135.9	142.1	146.6
Government and government enterprises	do.	131.1	133.8	136.2
Total	do.	635.4	<sup>2</sup> 650.5	653.9
<b>Personal income:</b>				
Total	millions	\$19,763	\$20,931	\$21,957
Per capita	do.	\$12,312	\$13,042	\$13,742
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do.	40.5	40.3	40.4
Total average hourly earnings, production workers	do.	\$8.9	\$9.0	\$9.3
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$1,318	\$1,690	\$1,923
Nonfarm	do.	\$13,024	\$13,713	\$14,263
Mining total	do.	\$68	\$79	\$71
Nonmetallic minerals except fuels	do.	\$22	\$23	\$19
Oil and gas extraction	do.	\$44	\$53	\$47
Manufacturing total	do.	\$2,043	\$2,083	\$2,137
Primary metal industries	do.	\$51	\$51	\$49
Stone, clay, and glass products	do.	\$55	\$58	\$59
Chemicals and allied products	do.	\$73	\$75	\$77
Petroleum and coal products	do.	\$7	\$7	\$4
Construction	do.	\$847	\$896	\$911
Transportation and public utilities	do.	\$1,537	\$1,559	\$1,559
Wholesale and retail trade	do.	\$2,421	\$2,525	\$2,583
Finance, insurance, real estate	do.	\$931	\$1,015	\$1,126
Services	do.	\$2,553	\$2,783	\$2,990
Government and government enterprises	do.	\$2,525	\$2,682	\$2,786

See footnotes at end of table.



Table 3.—Indicators of Nebraska business activity—Continued

	1984 <sup>P</sup>	1985	1986 <sup>P</sup>
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> .....	5,786	5,001	6,236
Value of nonresidential construction <sup>4</sup> .....	millions— \$280.1	\$286.4	\$247.0
Value of State road contract awards <sup>5</sup> .....	\$154.3	\$169.7	\$189.7
Shipments of portland and masonry cement to and within the State thousand short tons .....	835	794	775
<b>Nonfuel mineral production value:</b>			
Total crude mineral value .....	millions— \$100.4	\$100.0	\$94.1
Value per capita .....	\$63	\$62	\$59

<sup>P</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—During 1986, active mining operations in Nebraska included 659 sand, gravel, and silt or siltstone pits; 27 limestone quarries; 17 sandstone pits; and 6 clay or shale pits. These 709 operations disturbed 847 acres and restored 392 acres during 1986.<sup>3</sup>

**Exploration Activities.**—In September, Molycorp Inc., a subsidiary of Union Oil Co. of California, terminated its exploration drilling project on a rare-earth (carbonatite) target near Elk Creek, Johnson County. Exploration of the carbonatite had been sporadic since the early 1970's.

**Legislation and Government Pro-**

**grams.**—The Nebraska Wilderness Act of 1985 was signed into law October 20, 1986, as Public Law 99-504. Established as a result of the law was the 8,100-acre Soldier Creek Wilderness and the 6,600-acre Pine Ridge National Recreation Area. The Conservation and Survey Division of the University of Nebraska published a new State geologic bedrock map. Also published by the Division was a new map of the Precambrian surface. The Division participated in the Midcontinent Strategic and Critical Minerals Project, a study sponsored by the U.S. Geological Survey that includes all or part of 11 Midwestern States.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—In 1986, quantity and value of masonry cement posted a moderate decrease. Portland cement quantity and value were essentially unchanged for the same period. Value of cement produced in Nebraska accounted for about one-half of the total nonfuel mineral production value. The State's two cement producers, Ash Grove Cement Co. near Louisville in Cass County

and Ideal Basic Industries Inc., Cement Div., near Superior in Nuckolls County, produced both cement types. Most of the production was sold for ready-mixed concrete products and highway construction.

Cement shipments to and within Nebraska during 1986 included 764,000 short tons of portland and 11,000 tons of masonry.

Late in 1986, Ideal announced it would lay off 111 of 116 employees at its Superior plant by yearend. According to the com-

pany's 1986 annual report to stockholders, the plant was the company's oldest and least efficient. Closure of the plant was stated to be permanent; however, it was to be converted to a distribution terminal to serve its customers with products from other Ideal plants. Late in December, Ideal successfully completed negotiations with its lenders for a restructuring of its major unsecured debt and certain (unspecified) other claims and liabilities. One of the provisions of the agreement allowed for Holderman Inc., a wholly owned subsidiary of Holderbank Financiere Glaris Ltd., a Swiss Corp., to acquire about two-thirds of Ideal's common stock. Holderbank is one of the world's largest cement companies.

**Clays.**—Production and value of clays fell about 9% and 7%, respectively. Four companies produced common clay from five pits. Most of the production went into brick manufacturing, and the balance was used in portland cement mixtures. Endicott Clay Products Co. (Jefferson County) was the largest producer, followed by Ash Grove Cement Co. (Cass County), Yankee Hill Brick Manufacturing Co. (Lancaster County), and Omaha Brick Works (Douglas and Sarpy Counties).

**Gem Stones.**—Numerous small firms around Nebraska cut and polished gems and ornamental stones such as agate, chalcedony, chert, jasper, petrified wood, and quartz.

**Lime.**—Lime production accounted for a small fraction of the total nonfuel mineral production value in 1986 and had about a threefold increase in production and value. Western Sugar Co. shipped limestone from its quarry in Wyoming to plants at Scottsbluff and Mitchell in Scotts Bluff County and Bayard in Morrill County. Quicklime produced from the limestone was

used in sugar refining.

Lime consumption in Nebraska, from all domestic sources, totaled about 57,000 short tons, including 51,000<sup>1</sup> tons of quicklime and 6,000 tons of hydrated lime.

**Perlite (Expanded).**—The Zonolite Div. of W. R. Grace & Co. was the sole manufacturer of expanded perlite in Nebraska. Perlite from other States was expanded at its plant near Omaha and sold for use as aggregate for lightweight plaster and concrete, filler material, and as a horticultural product.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel accounted for about 25% of the State's total value of nonfuel mineral production, despite a nearly 17% decrease in value and quantity from 1985 estimates. There were 116 producers operating in 59 of 93 counties in the State. Lyman-Richey Sand & Gravel Corp. was the largest producer, followed by Western Sand & Gravel Co., Hartford Sand & Gravel Co., and Central Paving Sand & Gravel Co. Inc. Combined, these four companies accounted for about one-half of the total construction sand and gravel production in 1986. Counties with production in excess of 200,000 short tons are indicated in figure 1.

In the early spring, Lyman-Richey began operating a new 900-ton-per-hour electric, cutterhead dredge at Valley, Douglas County. The new dredge was reported to treble production over the previous plant. The plantsite included the new processing facility, industrial sand plant, and a ready-mixed concrete facility.<sup>4</sup>

Table 4.—Nebraska: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,826	\$4,829	\$2.64
Plaster and gunite sands -----	111	251	2.26
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	293	852	2.84
Asphaltic concrete aggregates and other bituminous mixtures -----	748	2,363	3.16
Road base and coverings <sup>1</sup> -----	2,308	5,603	2.43
Fill -----	360	525	1.46
Snow and ice control -----	20	52	2.60
Other <sup>2</sup> -----	89	410	4.61
Other unspecified <sup>3</sup> -----	3,920	9,047	2.31
Total or average -----	9,675	28,912	2.47

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes roofing granules.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Industrial.**—Western Sand & Gravel produced industrial sand from dredging operations along the Platte River. The sand was used for traction and sandblasting.

**Stone.—Crushed.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Estimated production and value in 1986 decreased slightly from figures reported in 1985. Major producing companies were Fort Calhoun Stone Co., Kerford Limestone Co., and Martin Marietta Aggregates. The greatest production was from Cass and Washington Counties.

Iowa Limestone Co. bought the ore processing equipment from American Cyanamid Co.'s limestone quarry near Weeping Water, Cass County. Occidental Chemical Corp., a division of Occidental Petroleum Corp., purchased the dicalcium phosphate feed-grade material stockpiled at the quarry and, under an agreement with Iowa Limestone, planned to continue to use the site as a warehousing point.

The Ampel Corp. received a \$125,000 grant from the Nebraska Department of Economic Development to establish a new limestone pellet plant at Weeping Water.

**Talc.**—The State's only producer of ground talc was Cyprus Industrial Minerals Co., Talc Div., at Grand Island in Hall County. Crude talc was shipped in from outside the State and sold, after processing, for use in ceramics, insecticides, paint, paper, rubber, textiles, and toilet articles.

**Vermiculite (Exfoliated).**—W. R. Grace produced exfoliated vermiculite at its plant

in Douglas County. Ore was shipped to the plant via rail from the company's mine and mill near Libby, MT.

## METALS

ASARCO Incorporated processed lead bullion at its Omaha refinery into antimonial lead and refined bismuth. The refinery was the only domestic source for primary bismuth production. According to the Asarco 1986 annual report to stockholders, the Omaha plant refined 58,200 short tons of lead, about 56% of the 1985 production and about 37% of the defined capacity. The decrease was due to the indefinite suspension of operations at Asarco's El Paso lead smelter owing to raw material shortages, which in turn affected production at the Omaha refinery.<sup>5</sup>

In April, Wyoming Fuels Co., a subsidiary of KN Energy Inc., sold its interest in the Crow Butte uranium deposit to its partner, Ferret Exploration Co., for an undisclosed price. In August, Ferret reported initial test results showed recovery of 400 pounds of uranium oxide (U<sub>3</sub>O<sub>8</sub>) from its pilot plant. Company ore reserve estimates were reported to be about 30 million pounds of U<sub>3</sub>O<sub>8</sub> at depths of about 650 feet in basal Chadron Formation of Oligocene age.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Research geologist, Conservation and Survey Division of the University of Nebraska (Nebraska Geological Survey), Lincoln, NE.

<sup>3</sup>Nebraska Geological Survey, Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska—Lincoln. Nebraska Mineral Operations Review, 1986. 19 pp.

<sup>4</sup>Rock Products. New Dredge Leads to Bigger Plant. V. 90, No. 9, Sept. 1987, pp. 46-48.

<sup>5</sup>ASARCO Incorporated. 1986 Annual Report. P. 13.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Ash Grove Cement Co -----	Box 25900 Overland Park, KS 66225	Quarry, clay pit, plant.	Cass.
Ideal Basic Industries Inc., a division of Holderbank Financiere Glaris Ltd.	Box 8789 Denver, CO 80201	Plant -----	Nuckolls.
<b>Clays:</b>			
Endicott Clay Products Co -----	Box 17 Fairbury, NE 68352	Open pit and plant	Jefferson.
Yankee Hill Brick Manufacturing Co.	Route 1 Lincoln, NE 68502	----_do -----	Lancaster.
<b>Lime:</b>			
Western Sugar Co -----	Anaconda Towers Suite 1400 555 17th St. Denver, CO 80202	Plants -----	Morrill and Scotts Bluff.
<b>Perlite (expanded):</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Douglas.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel (construction):</b>			
Central Paving Sand & Gravel Co. Inc	Box 626 Columbus, NE 68601	Pits and plants --	Butler, Madison, Nance, Platte, Stanton.
Hartford Sand & Gravel Co.-----	Box Z Valley, NE 68064	Dredges and pits -	Douglas and Hall.
Lyman-Richey Sand & Gravel Corp --	4315 Cuming St. Omaha, NE 68131	Pits and plants --	Cass, Douglas, Platte, Saun- ders.
Western Sand & Gravel Co. <sup>1</sup> -----	Box 28 Ashland, NE 68003	Dredges and pits -	Cass, Dodge, Saunders.
<b>Stone (crushed, 1985):</b>			
Fort Calhoun Stone Co -----	1255 South St. Blair, NE 68008	Quarries and plants.	Washington.
Kerford Limestone Co -----	Box 449 Weeping Water, NE 68463	Quarry and plant	Cass.
Martin Marietta Aggregates, Central Div	Box 30013 Raleigh, NC 27622	Quarries and plants.	Cass, Nemaha, Nuckolls, Paw- nee, Saunders.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Douglas.

<sup>1</sup>Also industrial sand in Saunders County.



# The Mineral Industry of Nevada

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

By Fred V. Carrillo<sup>1</sup> and John H. Schilling<sup>2</sup>

The value of Nevada's nonfuel mineral production in 1986 was \$977.3 million, an increase of \$346.4 million from that recorded in 1985. Nevada ranked eighth nationally in the value of its nonfuel mineral production.

Nevada led the Nation in the production

of barite and gold and was the sole producer of mined magnesite and mercury.

Gold continued to be the leading commodity produced in terms of value, accounting for \$773 million or 79% of the total nonfuel mineral value produced in the State.

Table 1.—Nonfuel mineral production in Nevada<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite----- thousand short tons--	615	\$14,924	590	\$10,904	184	\$3,005
Clays <sup>2</sup> ----- do-----	20	1,191	80	3,776	10	584
Gem stones-----	NA	<sup>e</sup> 1,300	NA	<sup>e</sup> 1,300	NA	213
Gold (recoverable content of ores, etc.)						
troy ounces--	1,020,546	368,068	1,276,114	405,369	2,098,929	772,909
Gypsum----- thousand short tons--	1,192	8,860	1,207	8,942	1,236	8,221
Lead (recoverable content of ores, etc.)						
metric tons--	W	W	<sup>(s)</sup>	<sup>(s)</sup>	W	W
Mercury----- 76-pound flasks--	19,048	W	16,530	W	W	W
Perlite----- short tons--	W	W	W	W	4	122
Sand and gravel:						
Construction--- thousand short tons--	8,202	20,505	<sup>e</sup> 9,500	<sup>r</sup> <sup>e</sup> 24,880	12,197	35,692
Industrial----- do-----	489	W	479	W	518	W
Silver (recoverable content of ores, etc.)						
thousand troy ounces--	6,477	52,727	4,947	30,383	6,409	35,056
Stone (crushed)--- thousand short tons--	<sup>e</sup> 1,100	<sup>e</sup> 4,700	1,334	6,218	<sup>e</sup> 1,500	<sup>e</sup> 7,000
Combined value of cement (portland), clays (fuller's earth and kaolin), copper, diatomite, fluorspar, iron ore (usable), lime, lithium compounds, magnesite, molybdenum (1984-85), salt, tungsten ore and concentrate (1984), and values indicated by symbol W-----	XX	151,787	XX	<sup>r</sup> 139,201	XX	114,529
Total-----	XX	624,062	XX	<sup>r</sup> 630,973	XX	977,331

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes certain clays; value included with "Combined value" figure.

<sup>3</sup>Less than 1/2 unit.

**Table 2.—Nonfuel minerals produced in Nevada in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Churchill -----	Salt, diatomite, silver, gold, stone (crushed).
Clark -----	Lime, sand (industrial), gypsum, stone (crushed), gold, silver.
Elko -----	Gold, barite, stone (crushed).
Esmeralda -----	Lithium, silver, gold, diatomite, clays.
Eureka -----	Gold, silver, mercury.
Humboldt -----	Gold, mercury, clays, stone (crushed), silver.
Lander -----	Gold, barite, copper, silver.
Lincoln -----	Gold, silver, perlite.
Lyon -----	Cement, diatomite, stone (crushed), gold, gypsum, silver.
Mineral -----	Gold, silver, mercury.
Nye -----	Gold, molybdenum, clays, silver, magnesite.
Pershing -----	Gypsum, diatomite, perlite, iron ore.
Storey -----	Diatomite, silver, gold.
Washoe -----	Gold, clays, silver.
White Pine -----	Gold, silver.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Table 3.—Indicators of Nevada business activity**

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	917	937	963
Total civilian labor force -----	do.	500	521	541
Unemployment -----	percent	7.8	8.0	6.0
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	6.6	6.1	6.3
Metal mining -----	do.	4.8	4.3	5.0
Manufacturing total -----	do.	21.0	21.9	22.2
Primary metal industries -----	do.	1.1	1.1	1.0
Stone, clay, and glass products -----	do.	1.4	1.4	1.5
Chemicals and allied products -----	do.	.7	.7	.8
Construction -----	do.	21.8	23.9	27.4
Transportation and public utilities -----	do.	24.9	25.3	26.6
Wholesale and retail trade -----	do.	85.9	90.9	94.8
Finance, insurance, real estate -----	do.	20.0	21.4	22.5
Services -----	do.	186.9	196.4	207.3
Government and government enterprises -----	do.	58.9	60.5	61.5
Total -----	do.	426.0	446.4	468.6
<b>Personal income:</b>				
Total -----	millions	\$12,672	\$13,779	\$14,870
Per capita -----		\$13,825	\$14,713	\$15,437
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		39.8	40.4	40.2
Mining -----		42.8	42.9	42.8
Total average hourly earnings, production workers -----		\$9.1	\$9.1	\$9.4
Mining -----		\$12.9	\$13.2	\$14.0
<b>Earnings by industry:<sup>1</sup></b>				
Farm income -----	millions	\$44	\$32	\$40
Nonfarm -----	do.	\$9,557	\$10,346	\$11,187
Mining total -----	do.	\$228	\$234	\$229
Metal mining -----	do.	\$156	\$154	\$186
Nonmetallic minerals except fuels -----	do.	\$46	\$44	\$11
Manufacturing total -----	do.	\$498	\$530	\$554
Primary metal industries -----	do.	\$40	\$40	\$36
Stone, clay, and glass products -----	do.	\$41	\$43	\$47
Chemicals and allied products -----	do.	\$22	\$22	\$24
Petroleum and coal products -----	do.	\$2	\$2	\$2

See footnotes at end of table.

Table 3.—Indicators of Nevada business activity—Continued

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>
Earnings by industry <sup>1</sup> —Continued			
Construction ----- millions .....	\$755	\$816	\$945
Transportation and public utilities ----- do .....	\$737	\$754	\$815
Wholesale and retail trade ----- do .....	\$1,371	\$1,500	\$1,609
Finance, insurance, real estate ----- do .....	\$429	\$478	\$548
Services ----- do .....	\$3,996	\$4,382	\$4,752
Government and government enterprises ----- do .....	\$1,506	\$1,610	\$1,689
Construction activity:			
Number of private and public residential units authorized <sup>2</sup> -----	13,868	14,004	15,655
Value of nonresidential construction <sup>3</sup> ----- millions .....	\$442.0	\$496.4	\$592.8
Value of State road contract awards <sup>3</sup> ----- do .....	\$168.0	\$114.0	\$128.6
Shipments of portland and masonry cement to and within the State thousand short tons .....	503	637	670
Nonfuel mineral production value:			
Total crude mineral value ----- millions .....	\$624.1	\$631.0	\$977.3
Value per capita -----	\$681	\$673	\$1,015

<sup>P</sup>Preliminary. <sup>T</sup>Revised.

<sup>1</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>2</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>3</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—Precious metals production and exploration continued to dominate Nevada's mineral industry. A dozen or more new mines were opened during the year to push the State's share of national gold and silver production even higher than in 1985. Nevada remained the leading gold-producing State, reporting 56% of the Nation's total gold production. Exploration continued at an increased pace in every county in the State, as an estimated 2,000 new jobs in the mining sector helped boost the economy of many rural Nevada counties.

Reduced levels of barite mining were again reported as foreign imports and a depressed demand from the oil industry kept prices low. Copper was restricted to a small amount of byproduct copper from gold mining, and no molybdenum or tungsten was mined in the State during 1986.

**Employment.**—According to the Nevada Employment Security Department, approximately 6,300 workers were employed in the Nevada mineral industry during 1986. The department reported an annual average of 5,040 employees in metal mining and 1,260 in other mining categories. The annual payroll for the State's nonfuel mining industry was approximately \$195 million.

Statistics collected by the Nevada Division of Mine Inspection, using a different method of computation than does the Employment Security Department, show that 8,255 mineral industry workers were reported employed in 395 active operations

during 1986. The largest number of employees were in gold operations followed by the sand and gravel industry.

**Legislation and Government Programs.**—The University of Nevada-Reno received the first installment of a \$10 million grant from the National Defense Stockpile Transactions Fund to expand the Mackay School of Mines into a national center for strategic minerals research. Preliminary plans were drawn up for the construction of a 79,000-square-foot building to house the Policy Center on Strategic Minerals and the school's Generic Center on Mineral Waste Treatment and Strategic Minerals Recovery. Ground-breaking ceremonies were held in May.

The Bureau of Land Management (BLM) completed an inventory of 10 former wilderness study areas that were reinstated to the wilderness study process after being dropped from wilderness review in 1982 and 1983. The 10 areas in Clark, Lincoln, and White Pine Counties comprise 176,724 acres adjacent to other Federal agencies' proposed wilderness or roadless areas.

A total of 29,447 claims were recorded during fiscal year (FY) 1986, which brought the total claims recorded in Nevada under the Federal Land Policy and Management Act to 378,098. BLM offices received 594 notices and 79 plans under the hard-rock mining regulations contained in 43 Code of Federal Regulations 3809. These totaled more than any other State with Federal lands.



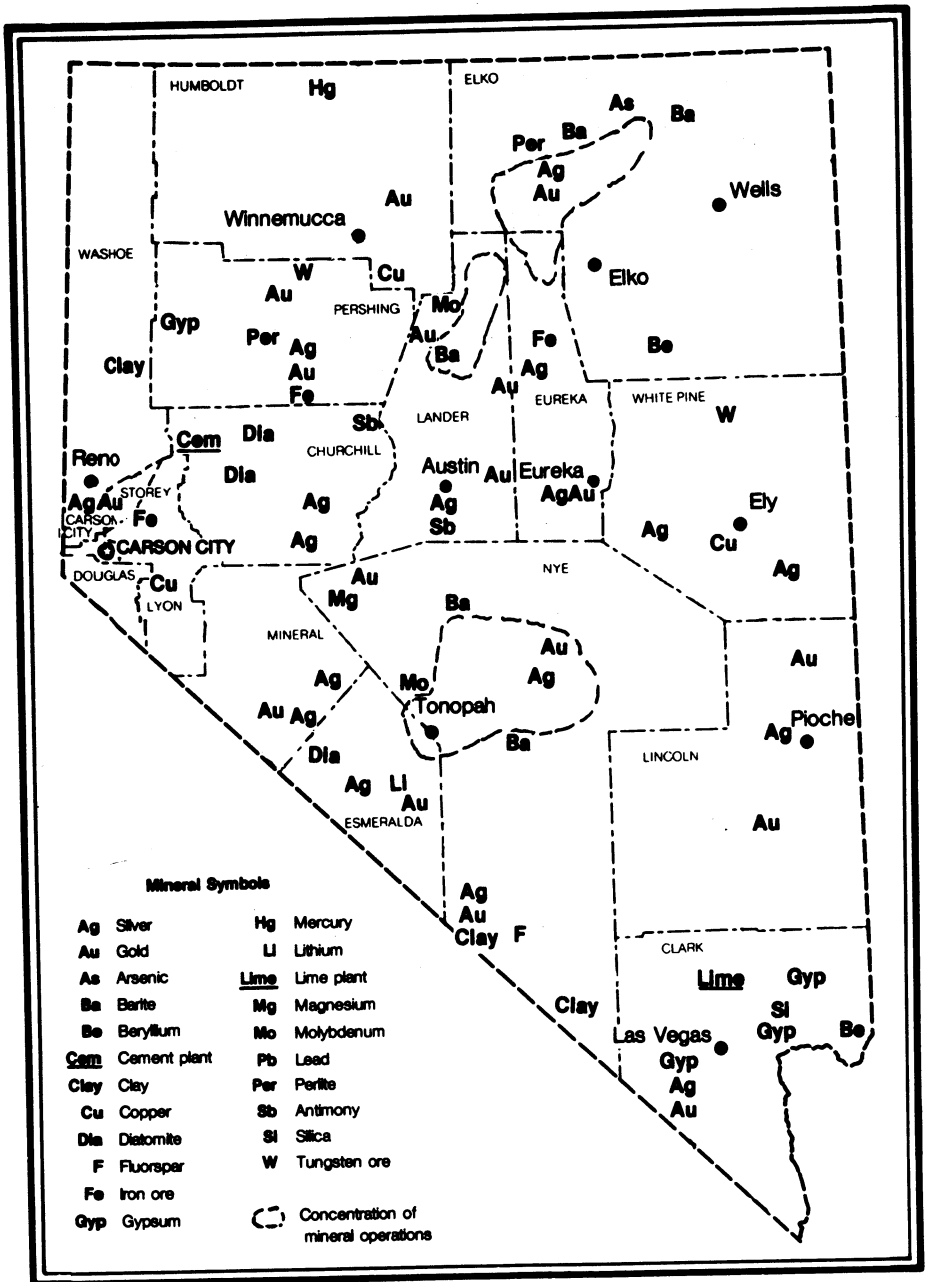


Figure 1.—Principal mineral-producing localities in Nevada.

In FY 1986, 10 lode and 120 placer claim patents were issued. Mineral materials sales by the BLM for public use—riprap, sand and gravel, and other salable minerals—in FY 1986 were 676,007 cubic yards valued at \$150,245. Free use permits were issued for 47,707,187 cubic yards valued at \$9,566,916.

The Nevada Bureau of Mines and Geology published "Bulk Mineable Precious Metal Deposits and Prospects in Nevada" and

"Tungsten Deposits of Nevada."

Three open-file reports were made available to the public: "Gypsum Deposits of Nevada," "Mineral Inventory and Geochemical Survey, Groom Mountain Range, Lincoln County, Nevada," and a 1:24,000-scale geologic map of the Bull Run Mountains in Elko County. A list of Nevada ore and concentrate buyers, custom mills, and smelters was also released.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

**Copper.**—Nevada's copper production, already ranking low among the copper-producing States, dropped even lower in 1986 as the The Anaconda Minerals Co.'s molybdenum operation remained closed. All of the State's production was derived from byproduct copper from Battle Mountain Gold Co.'s Fortitude Mine in Lander County. Both production and value decreased 74% from that of 1985.

**Gold.**—Nevada ranked first in the Nation in the amount and value of gold produced in 1986, accounting for 56% of the total amount produced in the United States. Production increased for the seventh consecutive year to 2,098,929 troy ounces valued at \$773 million.

Carlin Gold Mining Co. increased production in 1986 to 474,000 troy ounces. The increased production resulted from the opening of the Gold Quarry Mine and improved recoveries at the Carlin mill. Carlin Gold's name was changed to Newmont Gold Co., and 5% of the new company was sold to the public; Newmont Mining Corp. retained 95% interest. Mild weather permitted operation of the Gold Quarry dump leach throughout the fourth quarter of 1986, and 23% more ore per day was milled according to Newmont Gold. The company reported an increase of more than 20% over 1985 levels of gold production.

Freeport-McMoRan Gold Co. began production of gold from the new heap leach facilities at the Jerritt Canyon Mine (Enfield Bell), 50 miles north of Elko; leaching began August 7, and the first gold bar was poured August 18. The Jerritt Canyon operation is reported to have processed about 1.28 million short tons of ore with an output of 269,000 troy ounces of gold, a 13,650-ounce increase over that reported in 1985, ranking it third in the Nation among gold

producers.

Several mines in Eureka County reported significant gold production. Among these were Cominco American Incorporated's Buckhorn Mine, Silver State Mining Co.'s Tonkin Springs Mine, and Western States Minerals Corp.'s Gold Strike Mine. Silver King Mines Inc. and joint venture partner Pacific Silver Corp. began processing gold-silver ore at their new Lone Tree cyanide mill at Ruth, 6 miles west of Ely, in September.

Battle Mountain Gold, a spinoff from Pennzoil Co., reported increased production to 59,000 troy ounces at its Fortitude gold-silver mine at Copper Canyon, south of Battle Mountain, in Lander County. It reportedly was processing ore at a rate of 3,000 to 3,500 tons per day early in the year. Processing of the open pit mined ore was by a carbon-in-pulp mill.

Gold production at the Round Mountain Mine in Nye County, reportedly the world's largest heap-leaching operation, increased about 28,000 ounces in 1986 to approximately 168,000 ounces. Echo Bay Inc. announced plans to greatly expand its open pit heap-leaching operation at Round Mountain, including plans to build a new village for the additional workers needed.

AMAX Gold Inc., a wholly owned subsidiary of AMAX Inc., began production at its Sleeper open pit mine and mill in Humboldt County. The first shipment of gold-silver doré (containing 3,000 ounces of gold) was made March 26. Heap leaching of low-grade ore began in September. Production of 131,333 ounces of gold was reported for 1986 in a company prospectus.

FMC-Paradise Peak Corp., a wholly owned subsidiary of FMC Corp., poured the first doré bars at the Paradise Peak Mine 8 miles south of Gabbs on April 24.

Inspiration Resources Corp. finished construction at the Austin Gold Venture deposit southeast of Austin in Lander County and

poured its first gold bars December 6. Tenneco Minerals Co. poured its first gold doré bullion from the McCoy open pit mine and heap-leaching operation south of Battle Mountain in Lander County in May.

Pegasus Gold Inc. began construction at the Florida Canyon project at the north end of the Humboldt Range in Pershing County. Production began in September. Gold Shield Resources and Morgan Minerals began heap-leaching gold in the Goldfield District of Esmeralda County. Sunshine Mining Co. began open pit mining gold ore at Weepah in Mineral County in October. Ore was hauled 14 miles to Sunshine's

Sixteen-to-One mill east of Silver Peak.

Western Goldfields Co. began production at the Hog Ranch gold deposit 30 miles north of Gerlach in Washoe County. Leaching began in August and the first doré bullion was poured in September.

FRM Minerals Inc., a subsidiary of First Mississippi Corp., completed its first full year of gold production at the Getchell Mine in eastern Humboldt County. Heap leaching of dumps and open pit mining reportedly produced 10,100 ounces of gold. Five months were spent mining the ore with the heap-leaching operation running all year.

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

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (metric tons)	Gold		Silver		
	Lode	Placer		Troy ounces	Value	Troy ounces	Value	
1984, total	27	1	24,644,405	1,020,546	\$368,068,083	6,477,032	\$52,727,314	
1985, total	27	1	20,738,883	1,276,114	405,369,100	4,946,523	30,382,535	
1986:								
Churchill	1	--	W	W	W	W	W	
Clark	1	--	W	W	W	W	W	
Elko	2	--	W	W	W	W	W	
Esmeralda	2	--	252,379	8,839	3,254,874	848,193	4,639,616	
Eureka	7	--	10,443,842	W	W	195,244	1,067,984	
Humboldt	4	1	W	W	W	W	W	
Lander	6	--	4,912,040	422,792	155,688,926	W	W	
Lyon	1	--	W	W	W	W	W	
Mineral	3	--	W	W	W	W	W	
Nye	3	--	W	W	W	W	W	
Pershing	3	--	W	W	W	W	W	
Washoe	1	--	W	W	W	W	W	
White Pine	3	--	W	W	W	W	W	
Total	37	1	<sup>3</sup> 35,039,221	<sup>2</sup> 2,098,929	<sup>3</sup> 772,909,614	<sup>3</sup> 6,408,783	<sup>3</sup> 35,056,042	
			Copper		Lead		Zinc	
			Metric tons	Value	Metric tons	Value	Metric tons	Value
1984, total			W	W	W	W	--	--
1985, total			W	W	( <sup>4</sup> )	\$72	--	--
1986:								
Churchill	--	--	--	--	--	--	--	W
Douglas	--	--	--	--	--	--	--	W
Elko	--	--	--	--	--	--	--	W
Esmeralda	--	--	--	--	--	--	--	\$7,894,490
Eureka	--	--	--	--	--	--	--	W
Humboldt	--	--	--	--	--	--	--	W
Lander	--	W	W	--	--	--	--	W
Lyon	--	--	--	--	--	--	--	W
Mineral	--	--	--	--	--	--	--	W
Nye	--	--	--	--	--	--	--	W
Pershing	--	--	--	--	--	--	--	W
Washoe	--	--	--	--	--	--	--	W
White Pine	--	--	--	--	--	--	--	W
Total			W	W	W	--	--	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Operations from which gold and silver are recovered as byproducts from sand and gravel operations and operations from which metals are recovered as byproducts of molybdenum ore are not counted as producing mines.

<sup>2</sup>Does not include gravel washed.

<sup>3</sup>Includes data indicated by symbol W.

<sup>4</sup>Less than 1/2 unit.

**Table 5.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by class of ore or other source material**

Source	Number of mines <sup>1</sup>	Material sold or treated <sup>2</sup> (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
<b>Lode ore:<sup>3</sup></b>							
Dry gold -----	32	30,834,422	2,079,137	2,625,779	--	--	--
Gold-silver -----	2	W	W	W	--	--	--
Silver -----	3	W	W	--	--	--	--
Total -----	37	W	W	*6,408,783	--	--	--
<b>Other lode material:</b>							
Copper precipitates -----	1	W	--	--	W	--	--
Total lode -----	37	*35,039,221	W	6,408,783	W	--	--
<b>Placer</b>							
-----	1	--	W	--	--	--	--
Grand total -----	38	35,039,221	*2,098,929	*6,408,783	W	--	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Does not include gravel washed.

<sup>2</sup>Detail may not add to totals shown because some mines produce more than one class of material. Operations from which metals were recovered only from tailings or as byproducts from molybdenum ore are not counted as producing mines.

<sup>3</sup>Includes material that was leached.

<sup>4</sup>Includes data indicated by symbol W.

**Table 6.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
<b>Lode:</b>					
Amalgamation -----	19,500	W	--	--	--
Cyanidation -----	2,039,468	6,391,424	--	--	--
Smelting of concentrates -----	W	W	--	--	--
Direct smelting of precipitates -----	--	--	W	--	--
Total lode material -----	W	*6,408,783	W	--	--
<b>Placer</b>					
-----	W	--	--	--	--
Grand total -----	*2,098,929	6,408,783	W	--	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes data indicated by symbol W.

Kennecott entered into a joint venture with Plexus Inc. and Kiewit Mining Group Inc. to develop and operate an open pit gold-silver mine and heap-leaching operation at Rawhide in northern Mineral County. Gold Fields Mining Corp. plans to mine the Chimney Creek gold deposit in Humboldt County as a result of a feasibility study by the Davy McKee Corp. Mining will be by open pit methods.

Exploration continued at a high level in Nevada in 1986 with more than twice as many claims filed in Nevada than any other State. Canyon Resources discovered gold mineralization during drilling operations at the Cedar Mountain property near the junction of Esmeralda, Mineral, and Nye Counties. FMC continued exploration around its Paradise Peak Mine in search of other

gold-silver deposits. U.S. Minerals Exploration Co. did extensive drilling in 1986 for heap-leachable gold at Green Springs south of Hamilton in central White Pine County. Inland Gold Corp. reported that drilling at Westgate in eastern Churchill County encountered gold-silver mineralization.

Inspiration Resources continued precious metals exploration in the area around the Austin Gold Venture deposit southeast of Austin in Lander County. Silver King Mines Inc. continued to explore for gold in the Robinson Mining District of White Pine County. Westley Mines Ltd. conducted drilling in the Independence Range adjacent to the Jerritt Canyon open pit gold mine in Elko County.

Exploration drilling projects were reported in every county in the State during the

year. Several mining companies opened exploration offices in Reno. Additional exploration activity was reported by more than 25 companies throughout the State.

**Iron Ore.**—Nevada's iron ore shipments remained the same as those of 1985. Two producers shipped iron ore during the year, from Churchill, Eureka, and Pershing Counties.

**Mercury.**—Nevada was the only source of domestic primary mercury production in the United States during 1986. Production was reported from six mines, including byproduct mercury from five gold operations, with the principal production from Placer U.S. Inc.'s McDermitt Mine in Humboldt County. Mine production over the past 5 years has decreased as a result of lower prices due to the availability of low-cost foreign material and sale of mercury from Government stockpiles.

Byproduct mercury from five gold operations in the State accounted for 5% of the total reported production. Gold mines reporting production included CanAm Minerals Co.'s Borealis project; FMC's Paradise Peak Mine; Freeport-McMoRan's Jerritt Canyon (Enfield Bell) Mine; Newmont Gold's (formerly Carlin Gold) Carlin Mine; and Pinson Mining Co.'s Pinson Mine.

**Silver.**—Nevada ranked second among the Nation's silver producers in 1986. Production of 6,408,783 troy ounces of silver was 30% higher than that of 1985, although value rose only 15% to \$35,056,000.

NERCO Minerals Co.'s Candelaria Mine in Mineral County was the State's largest silver producer, reporting 2,406,334 troy ounces of silver from 2,824,647 short tons of material treated. FMC's Paradise Peak Mine in Nye County was the second largest silver producer, reporting 1,082,200 troy ounces, and Sunshine's Sixteen-to-One Mine in Esmeralda County was third with 831,881 troy ounces. Silver sold for an average price of \$5.47 per troy ounce during the year. Leading silver-producing counties were Mineral, Nye, and Lander.

Coeur Rochester Inc., a unit of Coeur d'Alene Mines Corp., brought its Rochester open pit silver-gold mine into production in August 1986. Morrison-Knudsen Co. Inc. provided mining and material handling, which was planned at a rate of 15,000 tons of ore per day. Recovery was by cyanide heap leaching; the leach pad was designed to ultimately cover 10 million square feet, the largest leach pad in mining history.

**Titanium.**—Titanium Metals Corp. of America (TMCA) produced titanium metal sponge and ingot from imported rutile concentrate at its Henderson plant. TMCA, the largest domestic titanium metal producer, has an annual capacity of about 14,000 short tons of sponge and 17,000 short tons of ingot.

**Tungsten.**—All Nevada tungsten operations were closed during 1986. The Nevada Bureau of Mines and Geology published a 1:1,000,000-scale map of tungsten deposits in Nevada in May entitled "Tungsten Deposits of Nevada" by Harold K. Stager and Joseph V. Tingley.

### INDUSTRIAL MINERALS

**Barite.**—The four major barite mining operations in Nevada—Dresser Industries Inc., IMCO Services Div. of Halliburton Co., NL Industries Inc., and Milpark Inc.—all laid off workers as mining and processing continued to decline. Barite production in 1986 decreased about 70% from that of 1985, to 184,000 short tons. Despite the large drop, Nevada remained the leading State in the production of primary barite, being credited with about 62% of the total production, although credited with only 24% of the total value reported nationally as the higher valued barite was produced in Georgia and Montana.

Dresser's Magobar Minerals Div.'s Grey-stone Mine and mill in Lander County and NL Industries' Baroid Div.'s Queen Lode Mine in Elko County were the largest producers. Additional production was reported from three mines in Lander County and one mine each in Churchill, Elko, and Nye Counties.

**Cement.**—Nevada Cement Co. continued to produce from a plant near Fernley in Lyon County, utilizing freshwater limestone mined nearby and clays mined in central Washoe County.

**Clays.**—The largest producer of Nevada clays, Industrial Mineral Ventures Inc., mined and produced sepiolite and bentonite in southern Nye County. Hectorite from California and bentonite from Wyoming were also processed at the plant to make high-value organo-clad clays for drilling fluid operations. Vanderbilt Minerals Co. continued to produce bentonite from its underground mine near Beatty in Nye County. Nevada Cement produced kaolin clay from its open pit mine northwest of Pyramid Lake in Washoe County.

**Diatomite.**—Nevada continued to be the second largest diatomite-producing State in 1986, with production and value nearly the same as that of 1985. Most of the diatomite produced was used for filtration purposes. Additional uses were in insulation and fillers. Three companies produced diatomite from Miocene or Pliocene freshwater lake deposits. Eagle-Picher Industries Inc. was the State's largest producer from properties in Lyon, Pershing, and Storey Counties. Grefco Inc. in Esmeralda County and Cyprus Diatomite Co. in Churchill County also produced diatomite during the year.

**Fluorspar.**—Nevada ranked second in the Nation in fluorspar production in 1986. Although the production increased slightly from that of 1985, value dropped 24%. J. Irving Crowell, Jr., and Son mined metallurgical-grade fluorspar at the Daisy Mine near Beatty in Nye County.

**Gem Stones.**—Gem stones valued at an estimated \$213,000 were produced in Nevada during 1986. Turquoise and opals were the most sought after gems.

**Gypsum.**—Nevada ranked sixth among the States in the production of both crude gypsum and calcined gypsum, reporting output of 1,236,207 short tons of crude gypsum valued at \$8,221,198 and 950,231 tons of calcined gypsum valued at \$16,197,534. Crude gypsum was mined in Clark, Lyon, and Pershing Counties, and calcined gypsum was produced in Clark and Pershing Counties. Although output was nearly the same as that of 1985, the value of crude gypsum dropped \$721,000 and calcined gypsum dropped \$476,000 owing to lower prices.

Pacific Coast Building Products Inc. and USG Corp. were the largest producers. The Genstar Building Materials Co. plant at Blue Diamond, west of Las Vegas, ran at

full capacity, producing wallboard. Pabco Gypsum Inc., a wholly owned subsidiary of Pacific Coast Building Products, announced plans to increase production at its plant in Henderson, Clark County, to 600 million square feet of wallboard.

**Lime.**—Chemstar Inc. produced quicklime and hydrates from properties in Clark County. Production was slightly higher than that reported in 1985.

**Lithium Compounds.**—Foote Mineral Co., a subsidiary of Newmont Gold, was the State's sole producer of lithium compounds, which were recovered from brines in Esmeralda County. Lithium carbonate was produced by solar evaporation and chemical processing of lithium-rich brines pumped from beneath the Clayton Valley Lake.

**Magnesite.**—Basic Inc.'s magnesite operation at Gabbs in Nye County continued to operate intermittently at a low production level. It remained the only magnesite producer in the United States. The material was used in refractories, in steel, and to make magnesium oxide.

**Perlite (Expanded).**—Nevada's expanded perlite production in 1986 came solely from USG's Empire plant in Washoe County. Delamar-Mackie Perlite Co. shipped crude ore from its mine near Caliente in Lincoln County.

**Salt.**—The Huck Salt Co. operation in Churchill County, owned by Leslie Salt Co., was the only reported salt producer in the State in 1986.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Table 7.—Nevada: Construction sand and gravel sold or used by producers in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,823	\$7,903	\$4.34
Plaster and gunitite sands -----	W	W	3.14
Asphaltic concrete aggregates and other bituminous mixtures -----	1,175	3,511	2.99
Road base and coverings <sup>1</sup> -----	1,928	4,997	2.59
Fill -----	440	1,273	2.89
Snow and ice control -----	60	179	2.98
Railroad ballast -----	8	41	5.13
Other -----	166	1,566	9.43
Other unspecified <sup>2</sup> -----	6,598	16,222	2.46
Total or average -----	<sup>3</sup> 12,197	35,692	2.93

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Sand and gravel for construction**, used primarily in concrete aggregates, asphaltic concrete aggregates, road base and coverings, and as fill, increased 49% in quantity produced to 12,197,134 short tons and 74% in value to \$35,691,695 from that of 1984. Production in 1986 was reported from 53 companies and 64 operations throughout the State, with 7 companies reporting more than 500,000 short tons and 16 companies reporting less than 25,000 short tons. The major portion of the production was from Clark and Washoe Counties. Douglas, Elko, Lyon, and Storey Counties also reported production of 300,000 short tons or more.

**Industrial.**—The Simplot Industries Inc. Silica Products Div.'s plant in Clark County was the only reported producer of industrial sand during 1986. Both production and value increased over that reported in 1985. Silica sand was used for containers, flux,

molding, and silicon carbide production.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Centex Corp.'s Nevada Cement, Chemstar, and Harney Rock & Paving Inc. were the largest producers. Production of 1,500,000 short tons valued at \$7 million was estimated to be 12% higher than that of 1985.

The Second Annual Convention of the National Stone Association was held in Las Vegas in February in conjunction with the biennial International Concretes and Aggregates Show.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Reno, NV.

<sup>2</sup>Director and State geologist, Nevada Bureau of Mines and Geology, Reno, NV.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Barite:</b>			
Dresser Industries Inc., Magobar Minerals Div. NL Industries Inc., Baroid Div	Box 370 Battle Mountain, NV 89820 Box 414 Battle Mountain, NV 89820	Surface mine and mill -----do-----	Lander. Elko.
<b>Cement:</b>			
Centex Corp., Nevada Cement Co	Box 895 Fernley, NV 89408	Plant	Lyon.
<b>Clays:</b>			
Industrial Mineral Ventures Inc	1800 East Sahara Ave. Suite 107 Las Vegas, NV 89104	Surface mine and mill	Nye.
<b>Copper:</b>			
Battle Mountain Gold Co	Box 1627 Battle Mountain, NV 89820	-----do-----	Lander.
<b>Diatomite:</b>			
Eagle-Picher Industries Inc., Minerals Div.	Box 12130 Reno, NV 89510	Surface mine and plants.	Lyon, Pershing, Storey, Esmeralda.
Grefco Inc., Dicolite Div	Box 288 Mina, NV 89422	Surface mine and plant	
<b>Fluorspar:</b>			
J. Irving Crowell, Jr., and Son	Box 96 Beatty, NV 89003	Underground mine	Nye.
<b>Gold:</b>			
Battle Mountain Gold Co	Box 1627 Battle Mountain, NV 89820	Surface mine and mill	Lander.
Carlin Gold Mining Co., a subsidiary of Newmont Mining Corp.	Box 979 Carlin, NV 89822	Surface mine, mill, refinery.	Eureka.
Freeport-McMoRan Gold Co., Joint Venture.	Mountain City Star Route Elko, NV 89801	Surface mine and mill	Elko.
<b>Gypsum:</b>			
Genstar Building Materials Co.	Box 2580 Irving, TX 75061	Surface mine and plant	Clark.
Pacific Coast Building Products Inc.	Box 405 37851 Cherry St. Newark, CA 94560	-----do-----	Do.
USG Corp	101 South Wacker Dr. Chicago, IL 60606	-----do-----	Pershing.
<b>Lime:</b>			
Chemstar Inc	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	-----do-----	Clark.
<b>Lithium compounds:</b>			
Footo Mineral Co	Route 100 Exton, PA 19341	Dry lake brines and plant.	Esmeralda.
<b>Magnesite:</b>			
Basic Inc	845 Hanna Bldg. Cleveland, OH 44115	Surface mine and mill	Nye.
<b>Mercury:</b>			
Placer U.S. Inc., McDermitt Joint Venture.	Box 497 McDermitt, NV 89421	-----do-----	Humboldt.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite (expanded): USG Corp -----	Empire, NV 89405 -----	Plant -----	Washoe.
Salt: Leslie Salt Co., Huck Salt Co -----	895 Harrigan Rd. Fallon, NV 89406	Solar evaporation plant.	Churchill.
Sand and gravel (construction): ARC Materials Corp., WMK Transit -----	Box 14697 Las Vegas, NV 89114	Pits and mills -----	Clark.
Eagle Valley Construction Co -----	5894 Sheep Dr. Carson City, NV 89701	Pits and mill -----	Carson City, Douglas, Lyon, Storey.
Granite Construction Co -----	Box 2087 Sparks, NV 89432	-----do -----	Washoe.
Robert L. Helms Construction Co -----	Drawer 608 Sparks, NV 89432-0608	-----do -----	Lander and Washoe.
Las Vegas Building Materials Inc -----	Box 530 Las Vegas, NV 89125	Pit -----	Clark.
Las Vegas Paving Corp -----	1770 South Industrial Rd. Las Vegas, NV 89102	Pit -----	Do.
Paiute Pit Aggregates Inc. -----	Box 159 Wadsworth, NV 89442	Pit and mill -----	Washoe.
Silver: FMC Corp -----	Box 1237 Gabbs, NV 89409	Surface mine and plant	Nye.
NERCO Minerals Co -----	Box 1246 Hawthorne, NV 89415	-----do -----	Mineral.
Sunshine Mining Co -----	Box 97 Silverpeak, NV 89047	Underground mine and mill.	Esmeralda.
Stone: Centex Corp., Nevada Cement Co -----	Box 840 Fernley, NV 89408	Quarry -----	Lyon.
Chemstar Inc -----	901 Mariner's Island Blvd. Suite 425 San Mateo, CA 94404	Quarries -----	Clark.
Harney Rock & Paving Inc -----	Box 800 Hines, OR 97738	Quarry -----	Elko.





# The Mineral Industry of New Hampshire

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

By Donald K. Harrison<sup>1</sup>

The value of nonfuel mineral production in New Hampshire in 1986 was \$38.6 million, a \$5.6 million increase compared with that of 1985. Construction sand and gravel and stone accounted for the majority of the State's mineral production. Common clay and a small amount of gem stones accounted for the remaining value. Gypsum, im-

ported into the State, was calcined and made into wallboard. Although virtually all of the State's mineral production was related to construction activity, the companies that supplied construction mineral aggregate continued to benefit from the continuing building boom in the Northeast.

Table 1.—Nonfuel mineral production in New Hampshire<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel (construction) thousand short tons	5,637	\$16,054	<sup>e</sup> 6,300	<sup>e</sup> \$19,800	8,418	\$26,089
Stone:						
Crushed	<sup>e</sup> 850	<sup>e</sup> 2,700	1,612	6,434	<sup>e</sup> 1,800	<sup>e</sup> 5,900
Dimension	<sup>r</sup> <sup>e</sup> 83	<sup>r</sup> <sup>e</sup> 5,681	<sup>r</sup> 80	<sup>r</sup> 6,625	<sup>e</sup> 82	<sup>e</sup> 6,451
Combined value of other industrial minerals	XX	160	XX	134	XX	137
Total	XX	<sup>r</sup> 24,595	XX	<sup>r</sup> 32,993	XX	38,577

<sup>e</sup>Estimated. <sup>r</sup>Revised. XX Not applicable.

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

**Table 2.—Nonfuel minerals produced in New Hampshire in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Cheshire -----	Stone (crushed).
Coccs -----	Stone (dimension).
Grafton -----	Stone (crushed).
Hillsborough -----	Stone (dimension).
Merrimack -----	Stone (dimension), stone (crushed).
Rockingham -----	Stone (crushed).
Strafford -----	Clays.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—As mineral producers sought to expand or open new operations, concern about the environmental impact of mining increased. In one such case, local officials denied a company permission to quarry granite for construction aggregate. The company then applied to the State for a mining permit through the Department of Resources and Economic Development (DRED). DRED considered the application acceptable but requested the

Attorney General's office to decide under chapter 155-E of the State's Code of Laws if the State had authority over local government to permit the quarry. The Attorney General's office ruled that local governments had jurisdiction over mining in their communities. At yearend, plans to develop the quarry were abandoned.

**Legislation and Government Programs.**—In June, House bill 430 (chapter 202) was signed into law, establishing a Department of Environmental Services. The new department consolidated all of the bureaus, boards, and commissions that regulate air, land, and water environmental issues into one central agency.

Controversy continued over the Mineral Management Service's offshore mineral exploration program in New Hampshire. The program was involved with evaluating placer deposits on the State's inner Continental Shelf with the intent of determining the extent of sand and gravel deposits. Opponents contend that any future mining along the State's 18 miles of coastline could eventually lead to major environmental damage.

**Table 3.—Indicators of New Hampshire business activity**

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	978	999	1,027
Total civilian labor force -----	do	521	538	562
Unemployment -----	percent	4.3	3.9	2.8
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	0.4	0.4	0.6
Manufacturing total -----	do	123.4	122.5	118.1
Primary metal industries -----	do	4.4	4.5	4.1
Stone, clay, and glass products -----	do	2.9	3.0	3.2
Chemicals and allied products <sup>1</sup> -----	do	1.0	1.0	1.0
Construction -----	do	25.2	30.9	34.5
Transportation and public utilities -----	do	15.5	15.7	16.7
Wholesale and retail trade -----	do	104.6	111.7	120.6
Finance, insurance, real estate -----	do	23.4	25.5	28.4
Services -----	do	91.5	99.3	107.8
Government and government enterprises -----	do	57.5	60.0	62.0
<b>Total</b> -----	do	441.5	466.0	488.7
<b>Personal income:</b>				
Total -----	millions	\$13,501	\$14,844	\$16,339
Per capita -----	do	\$13,801	\$14,860	\$15,911
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	41.0	40.7	41.2
Total average hourly earnings, production workers -----	do	\$7.9	\$8.4	\$8.8
<b>Earnings by industry:<sup>2</sup></b>				
Farm income -----	millions	\$35	\$40	\$42
Nonfarm -----	do	\$9,051	\$10,151	\$11,405
Mining total -----	do	\$31	\$44	\$48
Nonmetallic minerals except fuels -----	do	\$9	\$11	\$14
Manufacturing total -----	do	\$2,808	\$3,005	\$3,146
Primary metal industries -----	do	\$117	\$123	\$122
Stone, clay, and glass products -----	do	\$65	\$75	\$83
Chemicals and allied products -----	do	\$26	\$29	\$32
Construction -----	do	\$830	\$1,018	\$1,213
Transportation and public utilities -----	do	\$462	\$484	\$529
Wholesale and retail trade -----	do	\$1,524	\$1,734	\$2,007
Finance, insurance, real estate -----	do	\$443	\$516	\$660
Services -----	do	\$1,856	\$2,151	\$2,439
Government and government enterprises -----	do	\$1,063	\$1,157	\$1,261

See footnotes at end of table.

Table 3.—Indicators of New Hampshire business activity—Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
Construction activity:			
Number of private and public residential units authorized <sup>a</sup> .....	11,051	17,769	18,015
Value of nonresidential construction <sup>b</sup> .....	\$300.9	\$607.4	\$413.9
Value of State road contract awards <sup>c</sup> .....	\$71.5	\$73.5	\$85.7
Shipments of portland and masonry cement to and within the State thousand short tons .....	329	389	403
Nonfuel mineral production value:			
Total crude mineral value .....	\$24.6	\$33.0	\$38.6
Value per capita .....	\$25	\$33	\$38

<sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>b</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>c</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>d</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>e</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

**Clays.**—Kane-Gonic Brick Corp., the State's only producer, mined common clay at a pit in Gonic, Strafford County. The clay was used to manufacture face brick. Production and value remained about the same as that of 1985.

**Gem Stones.**—Mineral collectors and hobbyists collected semiprecious gem and mineral specimens from various sites within the State. Pegmatite minerals, fluorite, amazonite, topaz, and smoky quartz were some of the minerals collected.

**Gypsum.**—National Gypsum Co. operated a wallboard plant at Portsmouth, Rockingham County. The crude gypsum was shipped in from the company's subsidiary in

Canada. The plant was one of only two gypsum wallboard plants in New England.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel was produced in all of the State's counties. A total of 41 companies operated 57 pits. Leading counties, in order of output, were Hillsborough, Merrimack, Belknap, and Carroll. Main uses for the material were for concrete aggregates, road base and coverings, and asphaltic concrete aggregates.

Table 4.—New Hampshire: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) .....	1,568	\$6,144	\$3.92
Plaster and gunitite sands .....	83	427	5.14
Concrete products (blocks, bricks, pipe, decorative, etc.) .....	5	28	5.60
Asphaltic concrete aggregates and other bituminous mixtures .....	666	3,462	5.20
Road base and coverings .....	1,166	4,978	4.27
Fill .....	545	905	1.66
Snow and ice control .....	165	476	2.88
Other .....	7	44	6.29
Other unspecified <sup>1</sup> .....	4,212	9,625	2.29
Total or average .....	<sup>2</sup> 8,418	26,089	3.10

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>2</sup>Data do not add to total shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Output of 1.8 million short tons of crushed stone in 1986 matched the previous all-time high of 1973. This increase was the result of continuing strong demand by the construction industry, the primary end user. Both granite and basalt were produced at seven quarries in four counties,

in order of output: Merrimack, Cheshire, Grafton, and Rockingham. Leading uses were for bituminous aggregate, road surfacing, road base, and fill.

**Dimension.**—New Hampshire ranked fourth of 36 States that produced dimension stone in 1986. Four companies operated four quarries in Coos, Hillsborough, and Merrimack Counties. Primary uses were for rough blocks, curbing, and billiard tables.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
Kane-Gonic Brick Corp -----	Gonic, NH 03867 -----	Pit -----	Strafford.
<b>Gypsum (calcined):</b>			
National Gypsum Co. -----	4100 First International Bldg. Dallas, TX 75270	Plant -----	Rockingham.
<b>Sand and gravel:</b>			
Alvin J. Coleman & Sons Inc -----	Route 16 Conway, NH 03818	Pit -----	Carroll.
Nashua Sand & Gravel Co -----	Route 130 Nashua, NH 03060	Pit -----	Hillsborough.
Plourde Sand & Gravel Co. Inc. -----	Suncock, NH 03275 -----	Pit and plant ---	Merrimack.
Torromeo Trucking Co -----	33 Old Ferry Rd. Methuen, MA 01844	Pit -----	Rockingham.
A. Whitcomb Inc. <sup>1</sup> -----	Lancaster Rd. Gorham, NH 03581	Pits -----	Belknap, Carroll, Cheshire, Coos, Grafton, Cheshire.
F. W. Whitcomb Construction Corp. <sup>1</sup> -	Box 429 Bellows Falls, VT 05101	Pit -----	Cheshire.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
John Isafolla Co -----	Peverly Hill Rd. Portsmouth, NH 03801	Quarry -----	Rockingham.
Keene Sand & Gravel Co -----	725 Main St. Keene, NH 03431	---do-----	Cheshire.
Pike Industries Inc -----	Route 3 Tilton, NH 03276	---do-----	Merrimack.
<b>Dimension:</b>			
Kitledge Granite Corp -----	Armory Rd. Milford, NH 03055	---do-----	Hillsborough.
Maine-New Hampshire Granite Corp.	Box 135, Groton Rd. West Chelmsford, MA 01863	---do-----	Do.
J. Swenson Granite Co -----	North State St. Concord, NH 03301	---do-----	Merrimack.

<sup>1</sup>Also crushed stone.

# The Mineral Industry of New Jersey

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection, for collecting information on all nonfuel minerals.

By Donald K. Harrison<sup>1</sup>

The value of New Jersey's nonfuel mineral production in 1986 was \$186.2 million, an \$8.7 million increase over that of 1985. Crushed stone was the leading nonfuel mineral produced, accounting for more than one-half of the State's total value. Other minerals produced, in descending order of value, included construction sand and gravel, industrial sand, zinc, clays, greensand, and peat. Mineral commodities processed or

manufactured but not included in the State's total in table 1 included aluminum, copper, ferroalloys, graphite, gypsum, iodine, iron oxide pigments, perlite, quartz crystal, steel, sulfur, talc, and vermiculite.

Nationally, New Jersey ranked 35th in the value of nonfuel minerals produced. The State ranked fourth in output of industrial sand, sixth in zinc production, and sixth of 28 States that exfoliated vermiculite.

Table 1.—Nonfuel mineral production in New Jersey<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons --	62	\$611	130	\$2,050	133	\$2,066
Gem stones-----	NA	<sup>e</sup> 1	NA	<sup>e</sup> 1	NA	3
Peat ----- thousand short tons --	5	128	W	311	W	542
Sand and gravel:						
Construction----- do.-----	9,545	31,878	<sup>e</sup> 10,600	<sup>e</sup> 36,700	13,999	53,746
Industrial ----- do.-----	2,712	32,287	2,820	31,119	2,341	29,878
Stone (crushed)----- do.-----	<sup>e</sup> 13,500	<sup>e</sup> 75,000	15,692	94,339	<sup>e</sup> 15,300	<sup>e</sup> 95,400
Combined value of other industrial minerals	XX	<sup>f</sup> 16,183	XX	13,056	XX	4,613
Total -----	XX	<sup>f</sup> 156,088	XX	177,576	XX	186,248

<sup>e</sup>Estimated. <sup>f</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

**Table 2.—Nonfuel minerals produced in New Jersey in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Atlantic .....	Sand (industrial).
Camden .....	Do.
Cape May .....	Do.
Cumberland .....	Sand (industrial), clays.
Gloucester .....	Greensand, sand (industrial).
Hunterdon .....	Stone (crushed).
Mercer .....	Do.
Middlesex .....	Sand (industrial).
Morris .....	Stone (crushed).
Ocean .....	Sand (industrial).
Passaic .....	Stone (crushed).
Somerset .....	Stone (crushed), clays.
Sussex .....	Stone (crushed), zinc, peat.
Warren .....	Peat.
Undistributed <sup>2</sup> .....	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Table 3.—Indicators of New Jersey business activity**

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population .....	thousands ..	7,511	7,562	7,619
Total civilian labor force .....	do ..	3,828	3,835	3,892
Unemployment .....	percent ..	6.2	5.7	5.0
<b>Employment (nonagricultural):</b>				
Mining total .....	thousands ..	2.1	2.2	2.2
Nonmetallic minerals except fuels <sup>1</sup> .....	do ..	2.0	2.0	2.0
Manufacturing total .....	do ..	726.8	713.0	692.8
Primary metal industries .....	do ..	21.6	20.9	19.9
Stone, clay, and glass products .....	do ..	26.2	25.2	24.5
Chemicals and allied products .....	do ..	119.9	120.2	117.5
Petroleum and coal products .....	do ..	10.0	9.3	8.6
Construction .....	do ..	131.3	141.0	153.5
Transportation and public utilities .....	do ..	219.4	226.0	229.8
Wholesale and retail trade .....	do ..	787.3	813.2	832.8
Finance, insurance, real estate .....	do ..	183.0	194.9	208.9
Services .....	do ..	757.3	792.8	831.2
Government and government enterprises .....	do ..	522.1	531.1	535.7
Total <sup>2</sup> .....	do ..	3,329.2	3,414.3	3,486.9
<b>Personal income:</b>				
Total .....	millions ..	\$122,190	\$131,542	\$141,919
Per capita .....	do ..	\$16,268	\$17,398	\$18,626
<b>Hours and earnings:</b>				
Total average weekly hours, production workers .....	do ..	41.1	40.8	41.2
Total average hourly earnings, production workers .....	do ..	\$9.5	\$9.9	\$10.1
<b>Earnings by industry:<sup>3</sup></b>				
Farm income .....	millions ..	\$248	\$287	\$290
Nonfarm .....	do ..	\$80,587	\$87,360	\$95,110
Mining total .....	do ..	\$246	\$342	\$359
Nonmetallic minerals except fuels .....	do ..	\$56	\$60	\$66
Manufacturing total .....	do ..	\$19,991	\$20,675	\$21,287
Primary metal industries .....	do ..	\$664	\$650	\$665
Stone, clay, and glass products .....	do ..	\$678	\$687	\$726
Chemicals and allied products .....	do ..	\$4,181	\$4,401	\$4,562
Petroleum and coal products .....	do ..	\$537	\$533	\$535
Construction .....	do ..	\$4,733	\$5,306	\$5,973
Transportation and public utilities .....	do ..	\$6,985	\$7,454	\$8,022
Wholesale and retail trade .....	do ..	\$14,404	\$15,712	\$17,262
Finance, insurance, real estate .....	do ..	\$4,357	\$5,004	\$6,227
Services .....	do ..	\$18,305	\$20,531	\$22,739
Government and government enterprises .....	do ..	\$11,297	\$12,032	\$12,889

See footnotes at end of table.

Table 3.—Indicators of New Jersey business activity—Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> -----	44,031	55,027	57,352
Value of nonresidential construction <sup>4</sup> ----- millions .....	\$1,807.0	\$1,915.0	\$2,212.3
Value of State road contract awards ----- do -----	\$244.3	\$416.7	\$592.0
Shipments of portland and masonry cement to and within the State <sup>5</sup> ----- thousand short tons .....	1,740	1,821	2,059
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions .....	\$156.1	\$177.6	\$186.2
Value per capita -----	\$21	\$23	\$24

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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 growth of the construction industry in the State continued to outpace other sectors of the State's economy. Most of the growth took place in the nonresidential sector (14.6%) while residential construction contracts grew by only 0.9% compared with the first 10 months of 1985. Nevertheless, residential construction contracts surpassed \$3.6 billion during the same 10-month period of 1986, a very high level maintained for the last several years. The strong performance in this sector of the economy was reflected by the continuing strong demand for clays, construction sand and gravel, and crushed stone, which together accounted for four-fifths of the State's total mineral value.

**Legislation and Government Programs.**—Continuing concern about the quality of the State's air, land, and water resources resulted in the passage of several laws related to hazardous waste disposal and cleanup of existing sites. Several such bills concerning this subject were signed into law during 1986 (chapters 10, 29, 59, 68, 102, 144, and 170). Also during the year, the New Jersey Department of Environmental Protection (DEP) awarded a \$900,000 contract to a Florida firm for a remedial investigation feasibility study of 50 chromium-contaminated sites in Hudson County, 46 of which are in the Jersey City area. The contaminated sites were believed to have resulted from the use of chromium slag from three chromate processing indus-

tries as fill and diking material. It was estimated that the chromium operations resulted in the generation of about 2 million tons of alkaline waste containing from 2% to 5% chromium.

In September, chapter 94 was signed into law, which appropriated \$6 million from the Shore Protection Fund. The new law is expected to benefit local construction aggregate producers.

A new law (Chapter 432, Public Laws of 1985), effective in January, provided a strict regulatory framework to minimize the potentially adverse impact of oil and natural gas production operations without jeopardizing the economic benefits.

The New Jersey Geological Survey (NJGS) was the primary agency responsible for investigating the State's mineral resources and ground water.

The NJGS continued geologic mapping in the northern part of the State in cooperation with the U.S. Geological Survey. Approximately 50% of the State has been mapped in sufficient detail for inclusion in the 1:100,000-scale map to be published in 1990. Also in 1986, a statewide evaluation of ground water resources began; the findings of this study will be published with the geologic map. Combined, these two publications were expected to be useful in land use decisions and by the minerals industry in siting mines, processing and manufacturing plants.



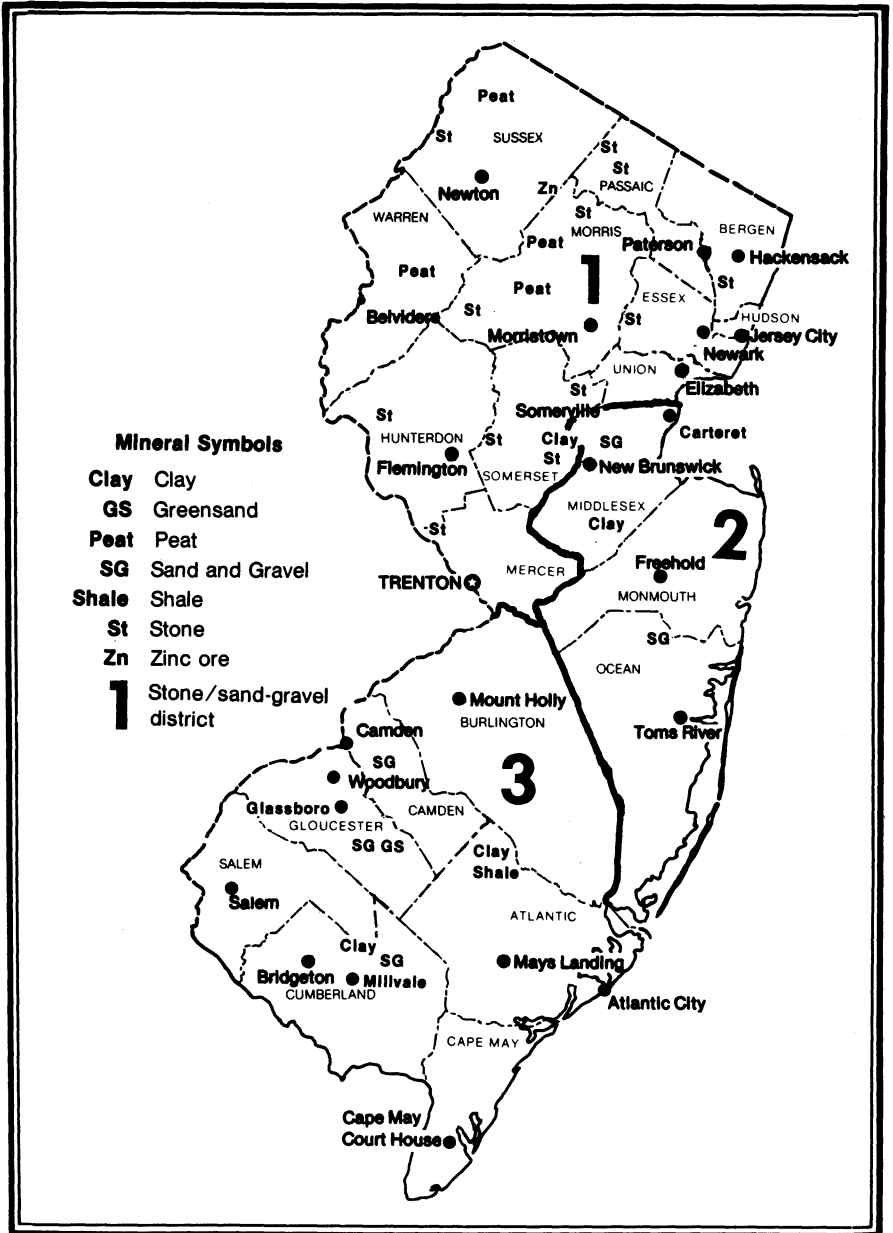


Figure 1.—Principal mineral-producing localities in New Jersey.

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

**Clays.**—Two companies produced clay in the State. New Jersey Shale Brick & Tile Corp. produced common clay and shale at an operation in Somerset County, and The Morie Co. Inc. mined fire clay in Cumberland County. Output of common clay was used primarily for manufacturing common brick; fire clay was used primarily in foundries.

In December, JPN Earth Hauling Inc. applied for a permit to mine a clay deposit on a 100-acre tract in Hamilton Township. The clay, believed to be bentonite, would be used to line, cover, and cap certain landfills in the State. Bentonite, relatively rare in New Jersey and the surrounding States, could possibly meet the New Jersey DEP's requirements that an impermeable clay be used for landfills. Because New Jersey has almost 500 landfills and disposal sites are at a premium, this clay could become an important economic resource. A series of zoning board hearings are expected to begin in early 1987. Because Hamilton Township outlawed all types of mining in 1985, the zoning board hearings are expected to be highly debated.

**Gem Stones.**—Amateur collectors and dealers collected gem stones and mineral specimens at various localities, especially at abandoned quarries and mineral refuse areas principally in the northern part of the State.

**Graphite (Synthetic).**—CCF Inc. Research Laboratory produced high-modulus synthetic graphite fibers at a plant in Summit.

**Greensand.**—New Jersey, one of two States that produced greensand, accounted for the majority of the Nation's total production. The Inversand Co., a subsidiary of Hungerford & Terry Inc., near Clayton, Gloucester County, was the sole producer. Greensand, also known as the mineral glauconite, is a hydrous iron potassium silicate containing various amounts of aluminum, magnesium, sodium, and trace elements. It was processed and sold mainly as a filtration medium to remove soluble iron and manganese from well water. A secondary use was as an organic conditioner for soils.

**Gypsum (Calcined).**—Crude gypsum, shipped in from Nova Scotia, Canada, was calcined by the National Gypsum Co., Burlington County, and Genstar Gypsum Prod-

ucts Co., Camden County. The calcined gypsum was used primarily in manufacturing wallboard and related products.

The Atlantic Gypsum Co. announced plans to build a \$34 million gypsum importing and wallboard plant at Port Newark in 1987. The contract to construct the plant was awarded to the U.S. subsidiary of Flack AB of Sweden. Construction is expected to be completed by yearend 1987, with the first production scheduled for early 1988. The gypsum feedstock for the plant, estimated to be at least 250,000 short tons per year, will be imported from Spain.

**Iodine.**—Crude iodine shipped into New Jersey was used by eight companies at nine plants to manufacture various iodine-containing compounds. These companies were General Chemical, Morristown; Cooper Chemical Co., Long Valley; Fisher Scientific Co., Fair Lawn; GAF Corp., Linden; Ganes Chemicals Inc., Carlstadt; J. T. Baker Chemical Co., Phillipsburg; Troy Chemical Corp., Newark; and White Chemical Corp., Newark. Iodine compounds were used for laboratory reagents and sanitary purposes and in pharmaceuticals and specialty organic and inorganic chemicals.

**Peat.**—Peat was mined at five operations in the State—four in Sussex County and one in Warren County. Both output and value rose in 1986 compared with those of 1985. The majority of the reed sedge and humus was packaged (88%), and the remainder was sold in bulk (12%). Most of the output was used for general soil improvement and as an ingredient in potting soil.

**Perlite (Expanded).**—Crude perlite shipped in from out of State was expanded by The Schundler Co. in Edison, Middlesex County. The expanded perlite was used in roof insulation, plaster aggregate, insulation and masonry, and as a soil conditioner.

**Quartz Crystal.**—Rowan Industries Inc., Wayside, Monmouth County, used cultured quartz crystal primarily for electronic applications.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Output totaled 14 million short tons valued at \$53.7 million in 1986, an increase in

both quantity and value compared with 1985 estimates. Construction sand and gravel was produced by 59 companies at 75 pits in 15 of the State's 21 counties and was used

primarily for concrete aggregates, asphaltic concrete aggregates, fill, and road base and coverings.

**Table 4.—New Jersey: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	2,927	\$11,094	\$3.79
Plaster and gunite sands -----	368	1,576	4.28
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	433	1,320	3.05
Asphaltic concrete aggregates and other bituminous mixtures -----	1,443	7,407	5.13
Road base and coverings -----	441	1,924	4.36
Fill -----	678	2,384	3.52
Snow and ice control -----	45	218	4.84
Other -----	206	673	3.27
Other unspecified <sup>1</sup> -----	7,458	27,150	3.64
Total or average -----	13,999	53,746	3.84

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Table 5.—New Jersey: Sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	864	5,015	842	3,598	2,022	5,436
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	856	5,156	263	759	765	3,416
Fill -----	188	644	38	113	451	1,628
Other unspecified <sup>3</sup> -----	2,203	9,207	3,804	14,185	1,702	4,649
Total <sup>4</sup> -----	4,112	20,021	4,947	18,595	4,940	15,130

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road base and coverings.

<sup>3</sup>Includes snow and ice control, other uses specified, production reported without a breakdown by end use, and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Nationally, New Jersey ranked fourth in industrial sand production in 1986. Nine companies operated 17 pits in 7 counties, producing 2.3 million short tons valued at \$29.9 million. The majority of the industrial sand was produced in Cumberland County, which accounted for 88% of the total State output. Principal uses of industrial sand were for glass products, mold and core, and in sandblasting.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Estimated crushed stone production totaled 15.3 million short tons valued at \$95.4

million. Leading counties in order of output were Somerset, Mercer, Sussex, and Morris. Major uses of crushed stone were for concrete aggregates, road base and coverings, and bituminous aggregates.

After 15 months of quarry hearings, the West Amwell Township Board of Adjustment, Hunterdon County, turned down a variance request to open a controversial 216-acre quarry within the township limits. Fort Commanche Inc. purchased the former Washington Rock Boy Scout camp for \$606,000 in 1983 for use as a quarry, but startup was postponed pending the township board's decision.

**Sulfur (Recovered).**—Elemental sulfur was recovered as a nondiscretionary by-product at four petroleum refineries in the

State. Mobil Oil Corp. and Texaco Inc. each operated a refinery in Gloucester County; Chevron U.S.A. Inc. operated a refinery in Middlesex County; and Exxon Co. U.S.A. operated the Bayway refinery in Union County. Sulfur was used in the manufacture of sulfuric acid, fertilizers, plastics, and other products.

**Talc.**—Talc mined in other States was shipped into New Jersey and processed by Cyprus Industrial Minerals Co. at a plant in South Plainfield. The talc was used primarily in the manufacture of paper, cosmetics, paint, plastics, and ceramics.

**Vermiculite (Exfoliated).**—Crude vermiculite was shipped into the State and exfoliated by W. R. Grace & Co., Construction Products Div., Trenton, Mercer County, and by Schundler, Edison, Middlesex County. Principal uses were for fireproofing, loose fill and block insulation, and as a horticultural agent.

## METALS

**Aluminum.**—Although no primary aluminum was produced in the State, Alumet Smelting Corp. operated a 1,400-metric-ton-per-year fully integrated, secondary smelter in Newark, Essex County.

**Copper.**—U.S. Metals Refining Co., a subsidiary of AMAX Inc., phased out most of its smelter operations at Carteret after extensive legal arguments with New Jersey and New York environmental authorities. In March, the New Jersey DEP issued an administrative order against AMAX that alleged a number of violations of the New Jersey Air Pollution Control Act and assessed civil fines and penalties totaling \$215,300. In May, AMAX reached an agreement with the State of New York ending a civil action, which alleged that emissions from the Carteret facility were harmful to the environment and the residents of Staten Island, New York. The court found no liability or wrongdoing on the part of AMAX concerning the State of New York's allegations. The consent judgment provided that the company continue fugitive dust control programs and permit the State of New York to inspect emission monitoring reports maintained by the company and the New Jersey DEP concerning the Carteret facility. The company also agreed to pay \$75,000 to the State of New York to remedy any environmental damage it may have incurred.<sup>2</sup>

**Ferroalloys.**—Shieldalloy Corp., a subsidiary of Metallurg Inc., operated a metallurgical furnace in Newfield, Gloucester County, and produced ferroalloys of aluminum, boron, columbium, titanium, and vanadium. Although shipments increased nearly 9%, value fell nearly 16% compared with that of 1985.

**Iron Oxide Pigments (Finished).**—Two companies produced finished pigments during the year—Columbian Chemicals Co., Monmouth Junction, Middlesex County; and American Minerals Inc., Camden, Camden County. Production and value increased by 11% and 8%, respectively, from 1985 levels.

**Steel.**—New Jersey Steel Corp. announced a \$10 million expansion project at its electric-furnace minimill in Sayreville. The project will involve installation of a new electric arc furnace and renovations that will increase production from 350,000 tons per year to 500,000 tons per year. About 95% of the production at the Sayreville plant is rebar.

In December, 440 production workers at the Raritan River Steel Co. began a union organizing drive at Perth Amboy, Middlesex County. The plant's production workers were planning to vote on whether they wished to be represented by the United Auto Workers, the United Steelworkers of America, or remain unorganized. Raritan River, a subsidiary of Co Steel International Ltd., Toronto, Canada, reprocessed scrap metal into wire rod ribbons for use in products such as steel belted tires, elevator shafts, and for use in submarines.

**Zinc.**—In March, The New Jersey Zinc Co. Inc.'s (NJZ) Sterling Mine shut down. The company laid off its last 40 workers and closed the 98-year-old, 120,000-short-ton-per-year mine because of large inventories, high operating costs, and low zinc prices. At its peak in the late 1940's and early 1950's, the mine employed nearly 500 workers. Direct shipping ore from the Sterling Mine was railed to the company's Palmerton, PA, plant to produce zinc oxide used to make rubber and in pharmaceuticals and paint. NJZ will rely on inventory and concentrates purchased on the open market for feedstock to the Palmerton plant.

<sup>1</sup>State Mineral Officer, U.S. Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>AMAX Inc. Securities and Exchange Commission Form 10-K, 1986, pp. 20-21.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
The Morie Co. Inc -----	1201 North High St. Millville, NJ 08322	Pit -----	Cumberland.
New Jersey Shale Brick & Tile Corp -----	Box 490 Somerville, NJ 08876	Pit -----	Somerset.
<b>Greensand:</b>			
Inversand Co., a subsidiary of Hungerford & Terry Inc. -----	Box 45 Clayton, NJ 08312	Pit -----	Gloucester.
<b>Gypsum (calcined):</b>			
Genstar Gypsum Products Co -----	1101 South Front St. Camden, NJ 08103	Plant -----	Camden.
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	----do----	Burlington.
<b>Iron oxide pigments (finished):</b>			
American Minerals Inc -----	Foot of Jefferson St. Camden, NJ 08101	----do----	Camden.
Columbian Chemicals Co -----	Box 37 Tulsa, OK 74102	----do----	Middlesex.
<b>Peat:</b>			
Glacial Soils Laboratory -----	R.D. 7 Owens Rd. Box 534 Sussex, NJ 07461	Bog -----	Sussex.
Kelsey Humus Co -----	Kelsey Park Great Meadows, NJ 07838	Bog -----	Warren.
Netcong Natural Products -----	Box 373AA, Pleasant Run Dr. Flemington, NJ 08822	Bog -----	Sussex.
Stan's Soils -----	R.D. 2, Box 129 Sussex, NJ 07461	Bog -----	Do.
<b>Perlite (expanded):</b>			
The Schundler Co. <sup>1</sup> -----	Box 251 Metuchen, NJ 08840	Plant -----	Middlesex.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Ralph Clayton & Sons -----	Box 928 Lakewood, NJ 08701	Pit -----	Ocean.
The Morie Co. Inc. -----	1201 North High St. Millville, NJ 08332	Pits -----	Atlantic, Cape May, Cumber- land.
NJ Pulverizing Co. <sup>2</sup> -----	115 Hickory Lane Bayville, NJ 08721	Dredge -----	Middlesex.
Tuckahoe Sand & Gravel -----	Box 248 Tuckahoe, NJ 08250	----do----	Cape May.
<b>Industrial:</b>			
George F. Pettinos Inc -----	123 Coulter Ave. Ardmore, PA 19003	Pit -----	Cumberland.
Unimin Corp., Dividing Creek Plant. -----	258 Elm St. New Canaan, CT 06840	Pit -----	Do.
Whitehead Bros. Co -----	Box 259, River Rd. Leesburg, NJ 08327	Pits -----	Do.
<b>Stone (1985):</b>			
<b>Granite (crushed):</b>			
Riverdale Quarry Co -----	125 Hamburg Turnpike Riverdale, NJ 07457	Quarry -----	Morris.
Tri-County Asphalt Corp -----	Route 15, Box 561, R.D. 3 Hopatcong, NJ 07843	----do----	Sussex.
<b>Traprock (basalt, crushed):</b>			
Little Ferry Asphalt Corp -----	650 Valley Rd. 9 Bergen Turnpike Clifton, NJ 07643	----do----	Passaic.
Millington Quarry Inc -----	Box 407 Millington, NJ 07946	----do----	Somerset.
Stavola Construction Materials Inc -----	Box 482 Red Bank, NJ 07701	----do----	Do.
Trap Rock Industries Inc -----	Box 419 Kingston, NJ 08528	Quarries -----	Hunterdon, Mercer, Somerset.
<b>Sulfur (recovered):</b>			
Chevron U.S.A. Inc -----	1200 State St. Perth Amboy, NJ 08861	Refinery -----	Middlesex.
Exxon Co. U.S.A -----	Box 23 Linden, NJ 07036	----do----	Union.
Mobil Oil Corp -----	Paulsboro, NJ 08066	----do----	Gloucester.
Texaco Inc -----	Eagle Point, Box 52332 Houston, TX 77052	----do----	Do.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Mercer.
<b>Zinc:</b>			
The New Jersey Zinc Co. Inc -----	Sterling Hill Mine Plant St. Ogdensburg, NJ 07439	Mine -----	Sussex.

<sup>1</sup>Also industrial sand.<sup>2</sup>Also exfoliated vermiculite.

# The Mineral Industry of New Mexico

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

By Lorraine B. Burgin<sup>1</sup> and Robert W. Eveleth<sup>2</sup>

The value of nonfuel mineral production in New Mexico declined from \$657 million in 1985 to \$612 million in 1986. Metal production, representing nearly two-thirds of the State's nonfuel output, decreased in 1986, partly because of continued low metal prices and the shutdown of the State's largest molybdenum operation. The total value of industrial minerals output weakened with the decrease in production of potassium salts; declines in value were also

posted for portland cement, gypsum, mica, perlite, and salt.

New Mexico's principal mineral commodities, listed in descending order of value, were copper, potassium salts, construction sand and gravel, portland cement, crushed stone, gold, and perlite. Nationally, New Mexico ranked 12th in total value of nonfuel mineral production, 1st in value of perlite, potassium salts, and pumice, and 2d in copper and mica.

Table 1.—Nonfuel mineral production in New Mexico<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons ..	67	\$143	60	\$161	60	\$170
Gem stones -----	NA	<sup>e</sup> 200	NA	<sup>e</sup> 200	NA	200
Gold (recoverable content of ores, etc.) troy ounces ..	W	W	45,045	14,309	39,856	14,677
Gypsum ----- thousand short tons ..	318	1,622	350	1,570	W	W
Lead (recoverable content of ores, etc.) metric tons ..	--	--	W	W	10	5
Perlite ----- thousand short tons ..	416	14,115	<sup>r</sup> 430	<sup>r</sup> 14,896	433	13,727
Potassium salts -- thousand metric tons ..	1,418	204,100	1,120	156,000	987	132,800
Pumice ----- thousand short tons ..	132	1,269	152	1,114	255	2,370
Sand and gravel (construction) ----- do ..	8,363	22,389	<sup>e</sup> 8,400	<sup>e</sup> 22,800	8,471	25,862
Stone:						
Crushed ----- do ..	<sup>e</sup> 4,700	<sup>e</sup> 17,000	3,641	15,232	<sup>e</sup> 3,900	<sup>e</sup> 15,300
Dimension ----- do ..	<sup>r</sup> 20	<sup>r</sup> 185	20	277	<sup>e</sup> 22	<sup>e</sup> 378
Combined value of cement, copper, helium (Grade-A), iron ore (usable, 1986), mica (scrap), molybdenum, salt, silver, tungsten ore and concentrate (1984), and values indicated by symbol W -----	XX	374,855	XX	430,705	XX	406,586
Total -----	XX	<sup>r</sup> 635,878	XX	<sup>r</sup> 657,264	XX	612,075

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in New Mexico in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Bernalillo	Cement, stone (crushed), clays.
Chaves	Stone (crushed).
Cibola	Perlite.
Colfax	Stone (crushed).
Curry	Do.
Dona Ana	Stone (crushed), stone (dimension), clays.
Eddy	Potassium salts, salt, stone (crushed).
Grant	Copper, silver, gold, molybdenum, stone (crushed), lead.
Hidalgo	Stone (crushed), clays, silver, gold, copper, lead.
Lea	Stone (crushed), salt.
Luna	Clays.
McKinley	Stone (crushed), molybdenum.
Otero	Stone (crushed).
Rio Arriba	Stone (crushed), pumice.
Sandoval	Gypsum, pumice.
San Juan	Stone (crushed), clays.
San Miguel	Stone (crushed).
Santa Fe	Gold, gypsum, pumice, stone (crushed), silver.
Sierra	Silver, gold, copper, lead.
Socorro	Perlite, stone (crushed), stone (dimension).
Taos	Molybdenum, perlite, mica (scrap), stone (crushed).
Torrance	Stone (crushed).
Union	Do.
Valencia	Stone (dimension).
Undistributed <sup>2</sup>	Sand and gravel (construction), helium (Grade-A), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—Although total value of metal production declined, copper experienced an economic turnaround despite continued low copper prices. The increase in output and value of copper was achieved principally through cost reductions in every phase of the operation. After several years of staggering losses, New Mexico's largest copper producer, Phelps Dodge Corp., again posted a profit and attributed its success to increasing total production, cutting costs, raising morale and productivity, and eliminating unprofitable operations. The company was also strengthened with the acquisition of the primary interest in the second largest copper operation in the State. Of the other major metals, molybdenum suffered the greatest decline. Gold production decreased; however, its value increased with an improved metal price. Silver, recovered principally as a byproduct of copper production, gained in quantity but slipped in value because of weak silver prices. The uranium-vanadium industry remained depressed, and most activity was diverted toward reclamation efforts.

Low prices and imports affected potash and cement, as reduced market demand resulted in curtailed production to work off excess inventories, employee layoffs, and

restructuring of several companies.

New Mexico's 1986 average unemployment rate was 9.2%; in counties dependent on mining, such as Eddy and Grant, the rate was about 14% and 12%, respectively. In the oil and gas industry, employment plummeted 33% as companies cut back because of sharply lower petroleum prices. With decreased revenue from the mining industry, the legislature increased the gross receipts tax and income tax to replace lost revenues.

**Exploration Activities.**—In November, Molycorp Inc. submitted a plan to the U.S. Forest Service for gold exploration near the Columbine-Hondo Wilderness Study Area south of the Red River, Taos County. An environmental impact study will be required for drilling the proposed 20 test holes.

Santa Fe County Development Review Committee granted Long Lac Exploration Inc, a wholly owned subsidiary of Lac Minerals Ltd. of Canada, a permit to drill an additional 12 holes for gold exploration in Lukas Canyon and the Iron Vein target area between Lukas and Carache Canyons.

In the Chloride District of the Black Range, Sierra County, St. Cloud Mining Co. continued to sample and evaluate precious-metal-bearing siliceous deposits destined for smelter flux.

Table 3.—Indicators of New Mexico business activity

		1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Employment and labor force, annual average:</b>				
Population	thousands	1,427	1,451	1,479
Total civilian labor force	do	629	642	672
Unemployment	percent	7.5	8.8	9.2
<b>Employment (nonagricultural):</b>				
Mining total	thousands	21.6	21.0	16.3
Metal mining	do	3.9	3.2	2.2
Nonmetallic minerals except fuels <sup>1</sup>	do	W	2.1	2.1
Coal mining <sup>1</sup>	do	W	2.1	2.1
Oil and gas extraction	do	13.4	13.6	10.0
Manufacturing total	do	36.5	37.3	37.5
Primary metal industries <sup>1</sup>	do	1.3	1.2	1.2
Stone, clay, and glass products <sup>1</sup>	do	2.7	2.8	2.7
Chemicals and allied products <sup>1</sup>	do	1.0	.8	.8
Petroleum and coal products <sup>1</sup>	do	.9	1.0	.9
Construction	do	36.6	37.5	35.3
Transportation and public utilities	do	29.9	30.0	29.3
Wholesale and retail trade	do	117.5	122.6	126.9
Finance, insurance, real estate	do	24.7	25.8	26.7
Services	do	106.3	113.2	117.7
Government and government enterprises	do	129.7	133.3	138.2
Total	do	502.8	520.7	527.9
<b>Personal income:</b>				
Total	millions	\$14,982	\$16,265	\$16,894
Per capita	do	\$10,500	\$11,210	\$11,422
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		39.9	39.8	39.5
Mining		41.9	42.3	40.0
Total average hourly earnings, production workers		\$8.0	\$8.4	\$8.8
Mining		\$11.5	\$11.9	\$12.6
<b>Earnings by industry:<sup>2</sup></b>				
Farm income	millions	\$170	\$245	\$245
Nonfarm	do	\$10,776	\$11,543	\$11,916
Mining total	do	\$697	\$712	\$576
Metal mining	do	\$131	\$117	\$85
Nonmetallic minerals except fuels	do	\$75	\$67	\$52
Coal mining	do	\$94	\$112	\$114
Oil and gas extraction	do	\$396	\$417	\$326
Manufacturing total	do	\$780	\$851	\$890
Primary metal industries	do	\$43	\$39	\$42
Stone, clay, and glass products	do	\$56	\$61	\$60
Chemicals and allied products	do	\$22	\$19	\$17
Petroleum and coal products	do	\$40	\$46	\$43
Construction	do	\$925	\$949	\$944
Transportation and public utilities	do	\$928	\$961	\$963
Wholesale and retail trade	do	\$1,670	\$1,794	\$1,858
Finance, insurance, real estate	do	\$467	\$518	\$576
Services	do	\$2,351	\$2,606	\$2,826
Government and government enterprises	do	\$2,902	\$3,107	\$3,234
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup>		16,525	11,790	11,513
Value of nonresidential construction <sup>3</sup>	millions	\$441.8	\$450.5	\$356.3
Value of State road contract awards <sup>4</sup>	do	\$220.1	\$209.5	\$311.0
Shipments of portland and masonry cement to and within the State	thousand short tons	628	630	581
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$635.9	\$657.3	\$612.1
Value per capita	do	\$446	\$453	\$414

<sup>p</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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



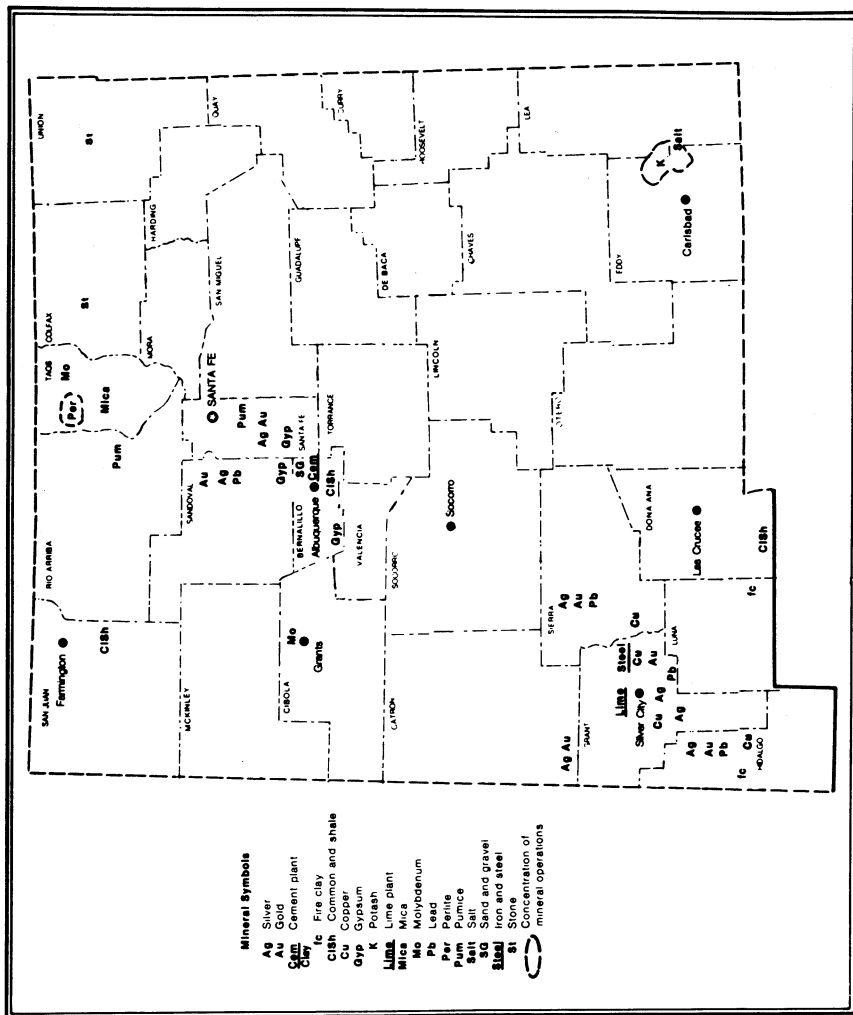


Figure 1.—Principal mineral-producing localities in New Mexico.

At the Valles Caldera on the Baca Land Grant in the Jemez Mountains, Sandoval County, the Los Alamos National Laboratory completed core drilling a hole 1/3-mile deep. Patchy molybdenite deposits as well as traces of copper, lead, and zinc were found between depths of 80 and 400 feet. The hole, second of three planned, was designed to gather scientific data on geothermal systems and the formation of ore deposits.

The New Mexico Bureau of Mines and Mineral Resources published a study on the geology, mineralization, and economic potential of the Organ porphyry deposit in the northern Organ Mountains and southern San Andres Mountains, Dona Ana County. Although the volume of mineralized material was large, values were noted as being well below typical cutoff grades.<sup>3</sup>

**Legislation and Government Programs.**—The U.S. Department of the Interior agreed in March to cut bond requirements and royalty rates for potash companies operating at or near a loss. Royalty rates were lowered from 4% to 2% for as much as 3 years if business profits remained inordinately low. Bonding requirements, which ranged from \$250,000 to \$650,000, were reduced to levels deemed sufficient for reclamation purposes.

Since 1979, the U.S. Bureau of Mines, in accordance with the Federal Land Policy and Management Act of 1976 (Public Law 94-579), has assessed the mineral values of U.S. Bureau of Land Management (BLM) managed lands that are being proposed for inclusion in the National Wilderness Preservation System. In 1986, the Bureau of Mines published open-file reports on 12 wilderness study areas known as Continental Divide and Horse Mountain in Catron County; Big Hatchet Mountains in Hidalgo County; Little Black Peak-Carrizozo in Lincoln County; Ignacio Chavez in McKinley and Sandoval Counties; Ojito in Sandoval County; Sabinoso in San Miguel County;

Antelope, Sierra de Las Canas, and Sierra Ladrones in Socorro County; and Jornada del Muerto in Sierra and Socorro Counties. The report identified some resources of coal, gypsum, lead, limestone, sand and gravel, sandstone, silver, and zinc on these lands, which cover over 233,000 acres.

The U.S. Supreme Court upheld the New Mexico Supreme Court's ruling that a private sand and gravel property in Chaves County was not included within the scope of a general mineral reservation and was, therefore, not subject to the Federal law that granted States rights to "all minerals of whatsoever kind." The U.S. Supreme Court rejected arguments by State officials that New Mexico owned mineral rights to the gravel pit even though it was on private property. In several cases, the State Highway Department removed or attempted to remove sand and gravel from the land without compensating the landowners. After a State judge held against the owners in a law suit against the State, the New Mexico Supreme Court overturned the ruling.

The U.S. Mine Safety and Health Administration and 18 representatives of government and industry established the Mining Industry Committee on Substance Abuse to address problems of drug use and related injuries in the workplace.

The U.S. Office of Surface Mining (OSM) awarded a \$1.1 million grant for reclamation projects at five New Mexico abandoned mines, bringing the total amount the State had received from OSM for restoration work to more than \$8.5 million. The projects included sealing a mine beneath the Western New Mexico University football stadium and closing 58 mine openings in the Boston Hill area in Grant County; closing 7 mine entries and 4 shafts of the Mirabal Fluorspar Mine in Cibola County; capping a shaft of a copper prospect in Santa Fe; and closing 9 coal mine openings in Socorro County.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

**Copper.**—Copper production in New Mexico rose about 6% in tonnage and 4% in value, although average producer-copper cathode prices dipped from \$0.67 per pound in 1985 to \$0.66 in 1986. Phelps Dodge's Tyrone Mine led in production, followed by Chino Mines Co.'s Santa Rita Mine, both

near Silver City, Grant County. A comparatively small amount of copper was obtained from The Goldfield Corp.'s St. Cloud Mine, Sierra County, and Mt. Royal Mining & Exploration Co.'s Center Mine, Grant County.

At Tyrone, Phelps Dodge operated its open pit mine, a 45,000-metric-ton-per-day concentrator, and a precipitate plant, while

the **Burro Chief Copper Co.**, a consolidated subsidiary of Phelps Dodge, managed the recently expanded 35,000-ton-per-year solvent extraction-electrowinning (SX-EW) plant. The SX-EW plant produced cathode copper at less than \$0.30 per pound (exclusive of mining costs), and the company planned another 21% expansion to supplement production when the Tyrone conventional concentrator is phased out in the early 1990's. According to the Phelps Dodge 1986 10K Annual Report to the Securities and Exchange Commission, 16,256,755 metric tons of ore with an average mill-level grade of 0.86% copper was mined; copper recovered from concentrates, precipitates, and by solvent extraction and electrowinning totaled 144,515 metric tons. As of December 31, 1986, ore reserves at Tyrone were an estimated 125.1 million metric tons of 0.79% copper.

Phelps Dodge produced more concentrates at its New Mexico and Arizona operations than its smelters at Playas, Hidalgo County, and Douglas, AZ, could treat; the excess concentrates were sold or toll smelted. The company's smelter capacity was scheduled to be lowered again with the permanent closure of the Douglas smelter in early January 1987. However, in late 1986, the company announced plans to acquire Kennecott's interests in the Chino Mines operation, including the Hurley smelter. Further, to raise the capacity of its Hidalgo smelter, increase energy efficiency, and improve costs, the company transferred a 454-metric-ton-per-day oxygen plant from its idled Morenci, AZ, smelter to the Hidalgo smelter at Playas. The \$9 million project, completed in mid-1986, was expected to raise the annual capacity of the Outokumpu-type flash-furnace smelter to 771,000 metric tons of concentrate, an increase of about 21%.<sup>4</sup>

Chino Mines, owned two-thirds by Kennecott and one-third by Mitsubishi Metal Corp. of Japan, operated the Santa Rita open pit mine, a 40,000-metric-ton-per-day concentrator, a precipitate plant near Silver City, and a smelter with an annual anode-copper capacity of 118,000 metric tons near Hurley. In November, Phelps Dodge purchased Kennecott's two-thirds interest in Chino Mines for \$88 million; in addition, the company planned an investment of \$20 million in working capital at the operation. The agreement excluded Kennecott's finished goods inventories to be

sold in 1987 and provided for additional payments, depending on the price of copper. Kennecott was indemnified from environmental, pollution, and reclamation obligations associated with the operations before and after the sale date. Phelps Dodge was to assume management of the properties on January 1, 1987.

Phelps Dodge also offered to purchase Mitsubishi's one-third interest in the Chino Mines property or to continue with the general partnership arrangement; by year-end, no agreement had been made.

With the acquisition of a share of the Chino Mines venture, Phelps Dodge expected to counterbalance the loss of ore reserves at Tyrone with production from the Chino Mines operation and to partially replace its Douglas smelter capacity from the Hurley smelter. Plans were to reduce production costs at the Santa Rita Mine and the smelter, to construct an SX-EW plant, and possibly to install an oxygen enrichment facility at the smelter. Phelps Dodge expected the Chino Mines annual production of 145,000 tons of copper to last for at least 20 years and at yearend, ore reserves were estimated to be 366 million tons of 0.72% copper.

In 1986, Kennecott's parent company, Standard Oil Co. of Ohio (Sohio) (owned 55% by the British Petroleum Co. PLC of the United Kingdom), reported a loss of \$342 million at its metals mining operations, including a \$334 million special charge for disposing of its Arizona Ray Mines Div. and New Mexico Chino Mines Div. operations. According to the 1986 Standard Oil Annual Report, Kennecott produced and sold 64,201 metric tons of copper, compared with 71,458 metric tons in 1985 (Ray, AZ, and Chino, NM, tonnage was excluded after June 30, 1986).

Developments at the Chino Mines operation during 1986, included in February, the smelter's first production of copper using the 22-mold anode casting wheel and furnace, which was transferred from the old Anaconda, MT, smelter to replace casting equipment formerly used to make blister copper. The anode copper will be shipped to El Paso, TX, for further refining. On July 15, Kennecott's unions voted 1,809 to 592 to ratify a new 4-year labor contract that cut wages by \$3.22 per hour to \$10.55; benefits were reduced an equivalent \$2.22 per hour; and local concessions, \$1.22. Phelps Dodge indicated those terms would be honored under the new management.

Boliden Minerals Inc. of Sweden, continued to evaluate and develop its Pinos Altos copper-zinc-silver project north of Silver City, Grant County, and was applying for the necessary permits. The U.S. Forest Service approved a plan for the tailings disposal site. New Mexico's Environmental Improvement Division approved the ground water discharge plan, providing the effluents were diluted with sufficient fresh water to meet the State's ground water standards.

**Gold.**—The value of New Mexico gold production, which ranked 8th nationally in 1985, dropped to 12th in 1986. Although the output of gold declined, its value increased with a rise in the average price of the metal from \$317.66 per troy ounce in 1985 to \$368.24 in 1986. The Ortiz Mine of Gold Fields Mining Corp. (a subsidiary of Consolidated Gold Fields PLC of the United Kingdom), continued as the leading gold producer, followed by the Tyrone Mine of Phelps Dodge, the Center Mine of Mt. Royal Mining & Exploration, Grant County, and the St. Cloud Mine of Goldfield, Sierra County.

Near Cerrillos, Santa Fe County, Gold Fields Mining's Ortiz operation reduced production throughout the year as its open pit mine and processing facilities were prepared for permanent closure near yearend. The company used a heap-leach and carbon-adsorption process to recover the micron-sized gold. According to the Consolidated Gold Fields 1986 annual report for the fiscal year ending June 30, 1986, the operation had produced 250,000 troy ounces of gold from about 5 million short tons of ore since its startup in 1980; production in 1986 totaled 33,581 troy ounces of gold. As it had from the onset of the project, the company continued to revegetate mined-out areas with grasses, junipers, pinyon, shrubs, and wildflowers.

A joint venture between Federal Resources Corp., Salt Lake City, UT, and Westar Corp. of Las Vegas, NV, planned to open pit mine the old Federal Resources properties 5 miles south of Lordsburg. Approximately 20,000 short tons per month was expected to be mined and treated. In September, the State issued a conditional use permit to heap leach gold-silver-copper ores. As of October 1986, Westar officials estimated ore reserves to be 487,000 short tons of 0.06 troy ounce of gold and 1 troy ounce of silver per ton.<sup>5</sup>

**Iron Ore and Steel.**—Sharon Steel Corp. shipped a small amount of magnetite iron

ore recovered earlier as a byproduct of copper production and stockpiled at the Continental Mine near Fierro, Grant County. Although shipments increased, their value declined.

In mid-1986, Luck Mines Co., owned by Roth Properties, San Francisco, CA, auctioned off the remaining equipment and assets of its manganiferous iron ore operation at Boston Hill, Silver City, Grant County. The hematite and pyrolusite ores had been mined since 1916 and shipped chiefly to the CF&I Steel Corp., Pueblo, CO, until May 1981, when CF&I permanently closed its blast furnaces and became a specialty mill using scrap steel. Although some ores had been shipped for smelter flux, Luck Mines lacked a steady market and efforts to sell the operation were unsuccessful.

Zia Steel Corp. continued to plan a specialty ministeel mill near Carrizozo, Lincoln County. The firm had optioned a 325-acre site at Coyote for the proposed \$150 million plant and, in 1986, sought environmental permits. Iron ore would be mined at the Jones Camp deposit west of Carrizozo in the northern Oscura Mountains, and coal would be shipped via rail from Raton.

**Lead.**—Lead production declined in quantity and value, with St. Cloud Mining the last remaining producer in the State.

**Manganese.**—Southwest American Minerals Inc. at Deming continued milling a 45-acre stockpile of manganese ore left by the General Services Administration after World War II. Reportedly, the mill produced 500 to 900 short tons of manganese a month in early 1986.<sup>6</sup>

**Molybdenum.**—Of six States shipping molybdenum concentrates, New Mexico ranked fourth in quantity. Molybdenum output declined sharply as Molycorp, a subsidiary of Union Oil Co. of California, shut down its Questa Mine and Chino Mines idled its molybdenum circuit because of continued slack demand and low dealer oxide prices. Total shipments of molybdenum concentrate declined about 81% in quantity and nearly 86% in value as the average dealer price of molybdic oxide declined from \$3.25 per pound in 1985 to \$2.87 in 1986.

Members of the Oil, Chemical and Atomic Workers Union at Molycorp's Questa Mine, Taos County, voted 255 to 175 on January 31 to reject a 20% wage concession and job reassignments contract proposed by the company. In an attempt to keep the mine open and competitive in a declining market,

the company had sought to amend the union's 3-year contract due to expire February 28. Instead, nearly 500 hourly and salaried employees were furloughed by the 28th, leaving approximately 100 hourly and 30 salaried workers on the job to conduct underground development and maintenance. The temporary shutdown was to last until conditions improved and molybdenum prices rose above \$3.50 a pound; however, by November 17, world molybdenum markets failed to recover and Molycorp suspended the development program and idled about 100 hourly and 15 salaried workers and retained 15 supervisors for care and maintenance of the operation. During the year, the company continued to negotiate with the labor force and the local electric company for cost reductions. Reclamation of a portion of the existing tailings area near the town was started, and plans were submitted to the BLM for a new tailings disposal area 3 miles west of Questa in the Guadalupe Mountains.

At Chino, new state-of-the-art column flotation equipment expected to reduce production costs was tested in the molybdenum circuit. Shipments of molybdenum concentrate declined.

**Silver.**—Although silver production increased 12% in quantity, its value remained essentially the same as that of 1985, reflecting a decline in the average silver price from \$6.14 per troy ounce in 1985 to \$5.47 in 1986. The State's leading producer was Phelps Dodge's Tyrone Mine, with silver being recovered as a byproduct of copper production. Other producers included Goldfield's (Melbourne, FL) St. Cloud silver-gold-copper operation in the Chloride mining district and the gold and byproduct silver operations of Mt. Royal Mining & Exploration's Center Mine in the Steeple Rock mining district, Grant County, and Consolidated Gold Fields' Ortiz Mine, Santa Fe County. Phelps Dodge obtained a minor amount of silver and gold from a small mine in Grant County.

In May, St. Cloud Mining shut down its underground mine and 400-short-ton-per-day flotation mill but continued to ship smelter flux material from surface mining, tailings, and waste dumps of some older mines such as the U.S. Treasury and Great Republic. In 1986, 87% of production was flux ore shipped directly to the smelter, compared with only 7% in 1985. Although Goldfield designated its St. Cloud property as a discontinued operation in 1985, the

company's 1986 annual report showed production of 25,459 pounds of copper, 97,216 troy ounces of silver, and 771 troy ounces of gold in 1986, compared with 244,069 pounds of copper, 120,321 troy ounces of silver, and 1,860 troy ounces of gold in 1985. St. Cloud Mining estimated reserves of 450,000 tons averaging 0.60% of copper, 5.76 troy ounces of silver per ton, and 0.034 troy ounce of gold in eight separate areas.

Sunshine Mining Co. completed a \$75,000 exploration project; however, because of depressed silver prices and unfavorable outlook for the metal in the near future, the company decided to drop its option on the St. Cloud property in June.

**Uranium-Vanadium.**—Among the few operations producing uranium in the State were Chevron Resources Co.'s Mount Taylor project near San Mateo, McKinley County, and Homestake Mining Co.'s mine and mill near Grants, Cibola County. Significant by-product vanadium had not been recovered in New Mexico since 1981.

Most action in the industry concerned reclamation of closed operations and tailings accumulated during the height of uranium activity. Major areas of uranium-vanadium wastes in the State included United Nuclear Corp.'s Church Rock site, Anaconda Minerals Co.'s Bluewater site, Homestake Mining's Milan site, Quivira Mining Co.'s Ambrosia Lake site, and Sohio's Laguna site. In May, citing severe budgetary constraints, the New Mexico Environmental Improvement Division returned jurisdiction over licensing and regulating the State's uranium mills to the Federal Nuclear Regulatory Commission.

In October, Anaconda Minerals, which operated the Jackpile-Paguete uranium project from 1953 to 1982, reached an agreement with the U.S. Bureau of Indian Affairs, BLM, and tribal officials to restore more than 2,600 acres of land disturbed by the operation on the Laguna Pueblo Indian Reservation west of Albuquerque. Three open pit mines, 9 underground mines, 32 waste dumps, and 66 acres of buildings and roads were scheduled for reclamation. Under the agreement, subgrade uranium ore would be backfilled into the open pit mines, covered with 4 feet of rubble and soil and revegetated; underground vents would be plugged. The \$43.9 million project was expected to take 10 years to complete and to employ 90 people.<sup>7</sup>

Quivira Mining, a subsidiary of Kerr-McGee Corp., proposed using hay grown in

Gore, OK, to hold moisture and stabilize tailings at its abandoned Phillips Petroleum Co. and UNC Resources Inc. uranium operations at the Ambrosia Lake and Church Rock areas. Reclamation work at the company's Shiprock mill was completed.

### INDUSTRIAL MINERALS

**Cement.**—Finished portland cement production increased; however, the quantity and value of sales dipped as the average cement price declined. Imports significantly impacted New Mexico markets.

The State's only cement operation, Ideal Basic Industries Inc., produced portland and masonry cement at its two-kiln dry-process Tijeras plant near Albuquerque. Raw materials consumed included gypsum, iron ore, and limestone; fuels used were natural gas and a small amount of coal. Listed in descending order of tonnage, finished portland cement was shipped to ready-mixed concrete companies, concrete product manufacturers, building material dealers, highway contractors, and others.

Experiencing financial difficulties because of depressed economic conditions, increasing cement imports, and other factors, Ideal Basic completed a debt restructuring plan in which, for \$110 million and other considerations, Holdernam Inc., a wholly owned subsidiary of "Holderbank" Financiere Glaris Ltd., a Swiss corporation, became 68.2% owner of the American company. Holderbank was one of the largest cement companies in the world.

Another company importing cement, Southwestern Portland Cement Co., a division of Southdown Inc., Houston, TX, completed a joint venture agreement to market Mexico's Cementos Mexicanos S.A. cement at Southwestern terminals, including one at Albuquerque.

**Clays.**—Total clay production remained essentially the same, with its value increasing modestly. The unit value of clays rose from \$2.68 in 1985 to \$2.83 per short ton in 1986. Common clay and shale output used principally for face brick rose nearly one-fourth. Other uses for New Mexico common clays included the manufacture of quarry and drain tile. Fire clay output required by smelters for plugging and tapping furnaces declined.

Common clay and shale was produced by El Paso Brick Co. Inc. at its Horte pit, Dona Ana County, Garcia & Sons Inc. at its Red Shale pit, San Juan County, Mathis & Mathis Mining & Exploration Co. at its

Lucretta pit, Luna County, and New Mexico Brick Co. Inc. at its Kinney pit, Bernalillo County. Phelps Dodge obtained fire clay at its Pratt Fire pit, Hidalgo County.

The New Mexico Bureau of Mines and Mineral Resources explored the effect of clay minerals on mobile hazardous materials in ground water. Noted also were the special properties of clays and the use of clay materials that could be engineered to be a more effective barrier to the movement of hazardous materials.<sup>5</sup>

**Gem Stones.**—A new occurrence of cyprine (blue idocrase) was reported at the 7th Annual Mineral Symposium held November 8-9, 1986, at the New Mexico Institute of Mining & Technology, at Socorro.<sup>9</sup>

**Gypsum.**—Following a national trend, New Mexico's output of crude gypsum increased in tonnage mined and declined in total value as the average value per short ton of crude gypsum continued to slump from \$5.10 in 1984 to \$4.49 in 1985 and to \$4.02 in 1986. Although calcined gypsum production rose, its value dropped significantly.

Gypsum was mined in Sandoval County by Centex American Gypsum Co. at the White Mesa Mine near San Ysidro and by Ernst Teeter Trucking Inc. at the San Felipe Mine. Centex American's ore was trucked to its plant in Albuquerque for calcining and manufacturing wallboard. The company announced plans for constructing a new \$20 million, 250,000-square-foot wallboard plant at Algodones, Sandoval County, north of Albuquerque. Western Gypsum Co. mined and calcined gypsum for wallboard at Rosario, Santa Fe County.

**Helium (Grade-A).**—Production of Grade-A helium continued to decline, falling 8% in quantity and value. A private company, The Navajo Refined Helium Co., extracted and liquefied helium from natural gas at Shiprock, San Juan County. The product was used principally in cryogenics, welding, and pressurizing and purging. Minor uses included synthetic breathing mixtures, chromatography, leak detection, lifting gas, heat transfer, and controlled atmospheres.

**Mica.**—Scrap and flake (crude) mica production declined more than one-third in quantity and value. New Mexico's only producer of the commodity, Mineral Industrial Commodities of America Inc., continued to obtain scrap mica at its Tojo Mine, in Taos County, and to operate a milling facility in Rio Arriba County. Of seven States

producing scrap and flake mica, New Mexico ranked second nationally in value of output. Ground mica was used in joint cement, paint, oil-well-drilling muds, roofing, and rubber.

**Perlite.**—Mined perlite ore increased about 11% to 645,000 short tons, and although sales of the processed ore rose, its value declined when the average price per ton of ore sold or used dropped from \$34.68 in 1985 to \$31.72 in 1986.

New Mexico accounted for nearly 88% of the total U.S. output of crude ore. The State's producers were Grecco Inc., Manville Products Corp., and Silbrico Corp., at No Agua Mountain near Tres Piedras, all in Taos County; Grecco near Socorro, Socorro County; and United States Gypsum Co. (a subsidiary of USG Corp.) near Grants, Cibola County. Processed ores were expanded primarily for construction-related products such as plaster, concrete aggregate, and insulation board. Other applications included filter aids and soil conditioners.

At its Socorro open pit mine, Grecco continued to process 12,000 to 13,000 short tons of perlite a month and to ship the unexpanded product to Canada, Pennsylvania, Texas, and other locations. Approximately 20 workers were employed at the operation.

**Potash.**—Of three states producing potash, New Mexico ranked first, with 87% of U.S. potassium salts output. Crude salt mine production and sales of potassium salts continued to decline, reflecting low potash prices. The average annual price for the three grades of muriate fell from \$96 per short ton in 1985 to \$81.88 in 1986.

Other factors contributing to the downturn included decreased demand from a depressed agriculture industry and imports, principally Canadian. Potassium salts,  $K_2O$  equivalent, imported for consumption in the U.S. rose to nearly 86% of the U.S. market in 1986, compared with 77% in 1985. New Mexico potash production was at its lowest point since 1950.

Employment in the State's potash industry fell to about 1,300 workers in 1986, compared with 4,500 in 1979. The industry cut costs by reducing wages and benefits and improving productivity. Effective June 1 through yearend 1987, Federal royalty payments covering the entire domestic industry were adjusted from a sliding scale of between 2% and 5%, depending on the ore grade, to a straight 2%. Beginning August 1, the State granted an 18-month reduction

in royalty payments to individual potash companies providing their own cost information to the New Mexico State Land Office, verifying the depressed conditions and losses.<sup>10</sup> Reductions in State royalties applied only as long as the average value of potash was under \$65 per ton. AMAX Chemical Corp. was the only company receiving the State's royalty reduction in 1986.

Companies producing potassium salts near Carlsbad were AMAX Chemical, renamed AMAX Potash Corp. in November; International Minerals & Chemical Corp. (IMC); Lundberg Industries Ltd.; New Mexico Potash Corp.; and Western Ag-Minerals Co.

AMAX Potash, which had shut down in October 1985, resumed production in April 1986 after a new labor contract with the United Steelworkers of America allowed a reduction in wages and benefits. Approximately 230 workers were employed as of October 1986. The company continued to phase out of the potash business, and mining at its Carlsbad properties was expected to be completed in mid-1989. Rated at an annual 850,000-short-ton-per-year of ore, mill operations were also being reduced. The 1984 AMAX 10K Annual Report, as of December 31, 1984, estimated reserves of 31 million short tons, averaging 13% potassium oxide.

IMC, the largest private potash producer in the world, with total capacity of about 5 million short tons per year, operated one mine near Carlsbad and two mines and plants with a combined annual capacity of 4.2 million short tons of muriate of potash near Esterhazy, Saskatchewan, Canada. The New Mexico ores included sylvinitic, a mixture of potassium chloride and sodium chloride, used for the production of muriate of potash; langbeinite, a double sulfate of magnesium and potassium marketed as a fertilizer; and a mixed ore containing sylvinitic and langbeinite used to produce sulfate of potash. The sulfates of potash, used to prevent chloride burning in some vegetables and many fruits crops, were not produced at Canadian operations. The 1986 IMC 10K Annual Report for the fiscal year ending June 30, 1986, noted that production of potash decreased from 812,000 short tons in 1985 to 782,000 short tons in 1986. IMC estimated reserves of 178 million short tons of recoverable ore; at current production rates, the company expected reserves would last more than 32 years. Operating nearly

continuously since 1940, the company had no layoffs since 1968. Employment in 1986 was about 587.

Lundberg Industries of Dallas, TX, acquired Ideal Basic's Potash Co. of America operations on December 31, 1985. Shut down since December 1, 1985, because of a large inventory and a slump in sales, the operation was reopened on March 4. Of the 400 idled employees, approximately 375 were initially rehired. Effective July 16, under a new contract between the company and representatives of the International Brotherhood of Electrical Workers, the International Association of Machinists, and the United Steelworkers of America, wages were reduced about 20%. By August, about 425 workers were employed and production of about 60,000 to 70,000 short tons per month was expected; however, inventory buildup forced a 3-1/2-month shutdown beginning November 22.

Mississippi Chemical Corp., with a rated capacity of approximately 400,000 short tons of muriate of potash per year, had been idle since January 1983. In the first quarter of 1986, Mississippi Chemical explored for langbeinite on company properties. The

Mississippi Chemical 10K Annual Report for the year ending June 1986 estimated reserves at 273 million short tons of recoverable ore with an average grade of 14.9% K<sub>2</sub>O.

New Mexico Potash, formerly owned by Kerr-McGee Chemical Corp., was sold to Vertac Chemical Corp., Memphis, TN, in April 1985. The entire Vertac company was sold in mid-1986 to Cedar Chemical Co, Memphis, the wholly owned subsidiary of Fermentab AB of Sweden. As of March 1986, New Mexico Potash was producing at a rate of 340,000 short tons of potash per year and employed about 230 workers.<sup>11</sup>

Western Ag-Minerals, a partnership of Warburg-Pincus Capital Partners of New York (75%) and Rayrock Resources Ltd., of Toronto, Canada (25%), furloughed about 125 workers from August 16 until early October, citing drought conditions in the Southeast and a depressed agricultural economy. The remaining workers continued to operate the prilling plant, which produced K-Mag, a coarse sulfate of potash magnesia product from langbeinite ores. Only IMC and Western Ag-Minerals marketed langbeinite.

Table 4.—Production and sales of potash in New Mexico

(Thousand metric tons and thousand dollars)

Period	Crude salts <sup>1</sup> (mine production)		Marketable potassium salts				
	Gross weight	K <sub>2</sub> O equivalent	Production		Sold or used		Value <sup>2</sup>
			Gross weight	K <sub>2</sub> O equivalent	Gross weight	K <sub>2</sub> O equivalent	
1985:							
January-June -----	6,160	827	1,221	623	1,322	666	93,900
July-December -----	5,152	683	1,014	479	927	454	62,100
Total -----	11,312	1,510	2,235	1,102	2,249	1,120	156,000
1986:							
January-June -----	4,397	636	971	463	1,085	522	73,500
July-December -----	5,382	777	1,147	588	927	465	59,400
Total -----	9,779	1,413	2,118	1,051	2,013	987	132,900

<sup>1</sup>Sylvinite and langbeinite.

<sup>2</sup>F.o.b. mine.

<sup>3</sup>Data do not add to total shown because of independent rounding.



**Pumice.**—Of eight States mining pumice, New Mexico was the top producer with 46% of the Nation's output. The quantity of processed pumice sold increased dramatically and its value more than doubled because of a greatly increased demand for pumice in concrete aggregate. Also, the average price rose from \$7.34 per short ton in 1985 to \$9.29 in 1986. Consumption of the product in abrasive cleaning compounds and building and decorative block declined, however, pumice sold for concrete block and other uses increased substantially.

Operations included the General Pumice Corp. Mine near Espanola, Rio Arriba County and mill in Santa Fe County; the Utility Block Co. Esquire 5-9 Mine near Ponderosa, Sandoval County; the American Pumice Co. mill near Santa Fe, Santa Fe County; and the Copar Pumice Co. Inc. Copar Mine near Los Alamos and mill near Pojoaque, Santa Fe County. The State's major pumice resources occur in the lower member of the Bandelier Tuff on the southern and eastern slopes of the Jemez Mountains in Sandoval, Santa Fe, and Rio Arriba Counties.

**Salt.**—Although salt output decreased nearly 3% in quantity, the value fell about 15%. In Eddy County, New Mexico Salt & Mineral Corp. harvested salt from potash tailings and United Salt Corp. dredged the product from a salt lake and an old tailings pond. In Lea County, Unichem International Co. pumped water into a salt formation at the Pioneer Water Station to produce a brine used in oil well drilling, and Williams Brine Co. similarly produced a brine for the

petroleum industry.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production in New Mexico increased in quantity and value. In 1986, 87 producers obtained construction sand and gravel in 29 counties. The major producing counties were Bernalillo, with more than 29% of the State's total, Sandoval, with about 16%, and Dona Ana, with about 9%. Listed in descending order of output, the following producers shipped more than 51% of the State's total sand and gravel: Springer Building Materials Corp., Aggregate Specialists of New Mexico, Albuquerque Materials Inc., S & S Aggregates Inc., J. R. Hale Contracting Co. Inc., Albuquerque Gravel Products Co., G. F. Atkinson Co., Avery Structures Inc., Connie H. Danley Construction Inc., and Armstrong & Armstrong.

As residential developments encroached on areas traditionally mined for sand and gravel, operators met with strong objections. For example, at Taos, the Extra Territorial Commission allowed an old sand and gravel producer to operate its sand and gravel pit only on the basis of a grandfather clause and not before submitting an extraction and reclamation plan. Local governments had obtained sand and gravel at the pit before zoning was introduced in 1979.

Table 5.—New Mexico: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	2,539	\$10,250	\$4.04
Plaster and gunita sands -----	230	995	4.33
Asphaltic concrete aggregates and other bituminous mixtures -----	605	1,683	2.78
Road base and coverings -----	1,587	3,782	2.38
Fill -----	331	564	1.70
Snow and ice control -----	(1)	1	6.00
Railroad ballast -----	W	W	1.50
Other -----	258	1,381	5.35
Other unspecified <sup>2</sup> -----	2,921	7,205	2.47
Total or average -----	8,471	\$25,862	3.05

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

<sup>1</sup>Less than 1/2 unit.

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Sulfur (Recovered).**—Elemental sulfur produced from natural gas operations declined about 15% in output, sales, and value of sales. Producers included Amoco Production Co. (a subsidiary of Amoco Corp., formerly Standard Oil Co., (Indiana), Marathon Oil Co. (a subsidiary of USX Corp.), and Phillips Petroleum Co., in Eddy County; Chevron USA Inc., El Paso Natural Gas Co., Phillips Petroleum, and Northern Natural Gas Co., in Lea County; Cities Service Oil Co. in Roosevelt County; and El Paso Natural Gas in San Juan County. Most production was from Eddy and Lea Counties.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.  
<sup>2</sup>Mining engineer, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.  
<sup>3</sup>Newcomer, R. W., Jr., and T. H. Giordano. Porphyry-Type Mineralization and Alteration in the Organ Mining District, South-Central New Mexico. NM Geol., v. 8, No. 4, Nov. 1986, pp. 83-86.  
<sup>4</sup>Epler, B. Phelps Dodge Boosting Playas Smelter. Southwest. Pay Dirt, No. 559, Jan. 1986, p. 5A.  
<sup>5</sup>American Metal Market. New Mexico Approves Mining Project. Oct. 15, 1986, p. 7.  
<sup>6</sup>Magg, J. B. Manganese; WW2 Ore Stockpile Still Providing Jobs. Deming Headlight, Apr. 18, 1986.  
<sup>7</sup>Walenga, K. Reclamation Agreement is Reached on Jackpile-Pagate Mine. Southwest. Pay Dirt, No. 571, Jan. 1987, p. 14A.  
<sup>8</sup>Austin, G. S. The Role of Clay Minerals in Disposal and Storage of Hazardous Materials. NM Geol., v. 8, No. 4, Nov. 1986, pp. 79-82.  
<sup>9</sup>New Mexico Geology. New Mexico Mineral Symposium. V. 9, No. 1, Feb. 1987. pp. 20-23; v. 9, No. 2, May 1987, p. 43.  
<sup>10</sup>Walenga, K. AMAX Chemical Gains Cut in New Mexico Potash Royalty. Southwest. Pay Dirt, No. 568, Oct. 1986, p. 23A.  
<sup>11</sup>Walenga, K. New Mexico Potash May Be Sold to Swedish Firm, Fermentab. Southwest. Pay Dirt, No. 561, Mar. 1986, p. 14A.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Ideal Basic Industries Inc., Ideal Cement Co. <sup>1</sup>	Box 100 Tijeras, NM 87059	Dry process, 2 rotary-kiln plants.	Bernalillo.
<b>Clays:</b>			
El Paso Brick Co. Inc -----	Box 12336 El Paso, TX 79913	Open pit mine -----	Dona Ana.
Garcia & Sons Inc -----	Box 841 Farmington, NM 87402	-----do -----	San Juan.
Mathis & Mathis Mining & Exploration Co.	Box 277 Silver City, NM 88062	-----do -----	Luna.
New Mexico Brick Co. Inc. (Kinney Brick Co. Inc.).	Box 1804 100 Prosperity Ave., SE, Albuquerque, NM 87103	-----do -----	Bernalillo.
<b>Copper:</b>			
Burro Chief Copper Co., a subsidiary of Phelps Dodge Corp.	Drawer B Tyrone, NM 88065	Solvent-extraction electrowinning plant.	Grant.
Chino Mines Co., a subsidiary of Phelps Dodge Corp.-Mitsubishi Metal Corp. partnership. <sup>2</sup>	Hurley, NM 88043 -----	Open pit mine, flotation mill, precipitation plant, smelter.	Do.
Phelps Dodge Corp.:			
Hidalgo Smelter <sup>3</sup> -----	Box 67 Playas, NM 88009	Smelter -----	Hidalgo.
Tyrone Branch <sup>4</sup> -----	Drawer B Tyrone, NM 88065	Open pit mine, mill, solvent extraction-electrowinning plant.	Grant.
<b>Gold:</b>			
Gold Fields Mining Corp., a subsidiary of Consolidated Gold Fields PLC of United Kingdom. <sup>5</sup>	Box 97 Cerrillos, NM 87010	Pit and heap-leaching operation.	Santa Fe.
<b>Gypsum:</b>			
Centex American Gypsum Co -----	Box 6345 Albuquerque, NM 87197	Pit and plant -----	Bernalillo and Sandoval.
Ernst Teeter Trucking Inc -----	Box 27317 Albuquerque, NM 87125	Open pit mine -----	Sandoval.
Western Gypsum Co., a subsidiary of Drywall Supply Inc.	Box 2636 Sante Fe, NM 87501	Open pit and wallboard plant.	Sante Fe.
<b>Mica:</b>			
Mineral Industrial Commodities of America Inc.	Box 2403 Santa Fe, NM 87504	Open pit mine and mill.	Rio Arriba and Taos.
<b>Molybdenum:</b>			
Molycorp Inc., a subsidiary of Unocal Corp.	Box 469 Questa, NM 87556	Underground mine and flotation mill.	Taos.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Perlite:</b>			
Grefco Inc., Minerals Div., a subsidiary of General Refractories Co.	Box 308 Antonito, CO 81120	Open pit mines; crushing, screening, air separation.	Socorro and Taos.
Manville Sales Corp., a division of Manville Products Corp.	Box 338 Antonito, CO 81120	--- do ---	Taos.
Silbrico Corp. -----	Box 367 Antonito, CO 81120	Open pit mine -----	Do.
United States Gypsum Co., a subsidiary of USG Corp.	Box 216 Grants, NM 87020	Open pit mine and crushing plant.	Cibola.
<b>Potash:</b>			
AMAX Potash Corp., a subsidiary of AMAX Inc.	Box 279 Carlsbad, NM 88220	Underground mine and plant.	Eddy.
International Minerals & Chemical Corp.	Box 71 Carlsbad, NM 88220	--- do ---	Do.
Lundberg Industries Ltd -----	Box 31 Carlsbad, NM 88220	--- do ---	Do.
New Mexico Potash Corp. of Ideal Basic Industries Inc. <sup>6</sup>	Box 610 Hobbs, NM 88240	--- do ---	Do.
Western Ag-Minerals Co., a partnership of Warburg-Pincus Capital Partners and Rayrock Resources Ltd.	Box 511 Carlsbad, NM 88220	--- do ---	Do.
<b>Pumice:</b>			
American Pumice Co., a division of Continental Equities Corp.	Box 4305 Santa Fe, NM 87502	Mill -----	Santa Fe.
Copar Pumice Co. Inc. -----	Box 38 Espanola, NM 87532	Open pit -----	Do.
General Pumice Corp. -----	Box 5135 Santa Fe, NM 87502	Open pit mine and crushing and screening plant.	Rio Arriba and Santa Fe.
Utility Block Co. -----	7200 2d St., NW Box 6036 Albuquerque, NM 87197	Open pit mines and crushing and screening plants.	Bernalillo and Sandoval.
<b>Salt:</b>			
New Mexico Salt & Minerals Corp. --	Box 2262 Carlsbad, NM 88220	Salt lake -----	Eddy.
Unichem International Co. -----	Box 1196 Eunice, NM 88321	Brine -----	Lea.
United Salt Corp., Carlsbad Div. ---	Box SS Carlsbad, NM 88220	Salt lake -----	Eddy.
Williams Brine Co. -----	851 Standpipe Rd. Carlsbad, NM 88220	Brine -----	Lea.
<b>Sand and gravel:</b>			
Aggregate Specialists of New Mexico	4825 Jefferson, NE. Albuquerque, NM 87109	Pit and plant -----	Sandoval.
Albuquerque Gravel Products Co. --	Box 829 Albuquerque, NM 87103	Dredge and plant ---	Bernalillo.
Albuquerque Materials Inc. -----	Box 6098, Station B Albuquerque, NM 87197	Pit and plant -----	Do.
Armstrong & Armstrong -----	Box 1873 Roswell, NM 88202	--- do ---	Chaves.
Avery Structures Inc. -----	Box 127 Ruidoso, NM 88345	--- do ---	Lincoln and San Juan.
Connie H. Danley Construction Inc. --	Drawer K Alamogordo, NM 88310	--- do ---	Otero.
J. R. Hale Contracting Co. Inc. ----	Box 25667 Albuquerque, NM 87125	--- do ---	Sandoval.
S & S Aggregates Inc. -----	Box 14379 Albuquerque, NM 87111	--- do ---	Bernalillo.
Springer Building Materials Corp. --	Box 572 Albuquerque, NM 87103	--- do ---	Do.
<b>Silver:</b>			
St. Cloud Mining Co. <sup>7</sup> -----	Box 1670 Truth or Consequences, NM 87901	Underground and surface mines and mill.	Sierra.
<b>Stone:</b>			
Big Chief Stone Inc. -----	900 North Morton Lane Las Cruces, NM 88005	Quarries -----	Colfax, Dona Ana, Santa Fe.
K & B Constructors Inc. -----	1437 Furneaux Rd. Marysville, CA 95901	Quarry -----	Socorro.
Rock Products Inc. (doing business as Bee Bee Contractors).	Box 154 Encino, NM 88321	--- do ---	Torrance.
<b>Uranium-Vanadium:</b>			
Chevron Resources Co. -----	Box 1150 Grants, NM 87020	Underground mine and concentrator.	McKinley.
Homestake Mining Co. -----	Box 98 Grants, NM 87020	--- do ---	Cibola.

<sup>1</sup>Also stone.<sup>2</sup>Also byproduct molybdenum.<sup>3</sup>Also fire clay and quartzite in Hidalgo County.<sup>4</sup>Also gold and silver.<sup>5</sup>Also silver.<sup>6</sup>Also salt.<sup>7</sup>Also lead and copper.

# The Mineral Industry of New York

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

By Donald K. Harrison<sup>1</sup> and William M. Kelly<sup>2</sup>

The value of nonfuel mineral production in New York was \$677.6 million, an increase of \$20.3 million compared with that of 1985. Leading mineral commodities produced in terms of value were crushed stone, portland cement, salt, and construction sand and gravel.

Nationally, the State ranked 11th in the

value of nonfuel minerals produced. New York was the only State that produced emery, and it accounted for most of the Nation's wollastonite production. The State ranked first in synthetic graphite production, second in primary aluminum, garnet and zinc output, third in salt production, and fourth in talc production.

Table 1.—Nonfuel mineral production in New York<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons ..	<sup>2</sup> 543	<sup>2</sup> \$2,435	700	\$3,129	619	\$3,075
Emery ----- short tons ..	W	W	W	W	2,878	W
Gem stones ..	NA	<sup>e</sup> 30	NA	<sup>e</sup> 30	NA	100
Salt ----- thousand short tons ..	5,644	123,755	<sup>r</sup> 7,044	142,318	5,071	122,601
Sand and gravel:						
Construction ----- do ..	25,968	80,866	<sup>e</sup> 28,000	<sup>e</sup> 88,500	31,172	103,748
Industrial ----- do ..	25	260	W	W	59	1,164
Stone:						
Crushed ----- do ..	<sup>e</sup> 33,100	<sup>e</sup> 135,000	35,139	165,136	<sup>e</sup> 40,600	<sup>e</sup> 196,600
Dimension ----- do ..	<sup>e</sup> 15	<sup>r</sup> 3,072	16	3,666	<sup>e</sup> 16	<sup>e</sup> 3,002
Combined value of cement, clays (ball clay, 1984), garnet (abrasive), gypsum, lead, lime (1984-85), peat, silver, talc and pyrophyllite, titanium concentrate (ilmenite, 1984), wollastonite, zinc, and values indicated by symbol W ..	XX	265,873	XX	254,529	XX	247,272
Total ..	XX	<sup>r</sup> 611,291	XX	657,308	XX	677,562

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes ball clay; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in New York in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Albany	Cement, stone (crushed), clays, stone (dimension).
Broome	Peat, clays.
Cattaraugus	Peat.
Clinton	Stone (crushed).
Columbia	Do.
Delaware	Stone (crushed), stone (dimension).
Dutchess	Stone (crushed), peat.
Erie	Stone (crushed), clays.
Essex	Wollastonite, stone (dimension), stone (crushed).
Franklin	Stone (crushed), stone (dimension).
Genesee	Stone (crushed), gypsum.
Greene	Cement, stone (crushed).
Herkimer	Stone (crushed).
Jefferson	Do.
Lewis	Wollastonite, stone (crushed).
Livingston	Salt, stone (crushed).
Madison	Stone (crushed).
Monroe	Do.
Montgomery	Do.
Niagara	Do.
Oneida	Stone (crushed), sand (industrial).
Onondaga	Lime, stone (crushed), salt, clays.
Ontario	Stone (crushed).
Orange	Stone (crushed), clays.
Orleans	Stone (crushed), stone (dimension).
Putnam	Stone (crushed).
Rensselaer	Do.
Rockland	Do.
St. Lawrence	Zinc, stone (crushed), talc, lead, silver.
Saratoga	Stone (crushed), sand (industrial).
Schoharie	Cement, stone (crushed).
Schuyler	Salt.
Seneca	Stone (crushed), peat.
Steuben	Stone (crushed).
Sullivan	Do.
Tompkins	Salt, stone (crushed), stone (dimension).
Ulster	Stone (crushed), clays.
Warren	Cement, stone (crushed), abrasives.
Washington	Stone (crushed), stone (dimension).
Wayne	Stone (crushed).
Westchester	Abrasives, stone (dimension), peat.
Wyoming	Salt.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Legislation and Government Programs.**—The New York State Environmental Quality Bond Act, which went into effect in 1986, provided \$1.2 billion to clean up 500 hazardous waste sites identified as significant threats to the public health or environment. Some of the sites identified included past mineral processors. It was estimated that this effort will take 13 years to complete. In 1986, allocations from the Federal Clean Water Act and New York State's 1965 Pure Waters Act and 1972 Environmental Quality Bond Act funded 41 construction projects and 38 wastewater treatment facilities, which significantly added to the demand for construction aggregates.

The New York State Energy Research and Development Authority funded out-of-State tests aimed at increasing the use of coal in New York to reduce the State's dependency on foreign oil. Increased use of domestic coal as a fuel source will depend

on finding successful technologies that would meet stringent sulfur dioxide emissions regulated by the State Acid Deposition Act of 1984.<sup>3</sup>

The New York Geological Survey performed two basic functions: (1) it provided geological information to government agencies, the mineral industry, and the public, and (2) it acted as the geological research arm of the New York State Museum. In 1986, the survey was involved in 12 major projects—3 related to environmental and engineering geology, and 9 to regional geologic studies. Individual project topics included compiling engineering geologic data on the New York City water supply system, bedrock quadrangle mapping and seismic studies of the Adirondack Mountains, and quaternary geologic mapping and cataloging of the mineral resource localities in the northern part of the State.

Table 3.—Indicators of New York business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	17,713	17,746	17,772
Total civilian labor force -----	do	8,090	8,312	8,408
Unemployment -----	percent	7.2	6.5	6.3
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	6.8	6.6	5.9
Nonmetallic minerals except fuels <sup>1</sup> -----	do	3.8	3.9	3.8
Oil and gas extraction <sup>1</sup> -----	do	2.6	2.6	2.2
Manufacturing total -----	do	1,326.3	1,293.1	1,250.5
Primary metal industries -----	do	33.5	30.6	28.4
Stone, clay, and glass products -----	do	31.9	30.1	30.6
Chemicals and allied products -----	do	65.6	64.8	62.7
Petroleum and coal products -----	do	5.6	5.1	4.9
Construction -----	do	255.2	285.6	308.6
Transportation and public utilities -----	do	418.5	416.1	402.1
Wholesale and retail trade -----	do	1,576.9	1,631.2	1,675.6
Finance, insurance, real estate -----	do	704.4	721.7	754.6
Services -----	do	1,966.1	2,042.9	2,125.9
Government and government enterprises -----	do	1,318.2	1,353.6	1,382.3
Total <sup>2</sup> -----	do	7,572.3	7,750.8	7,905.6
<b>Personal income:</b>				
Total -----	millions	\$266,112	\$282,914	\$304,095
Per capita -----	do	\$14,967	\$15,942	\$17,111
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	39.8	39.8	39.9
Total average hourly earnings, production workers -----	do	\$9.2	\$9.7	\$9.9
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$556	\$600	\$696
Nonfarm -----	do	\$194,184	\$210,035	\$227,391
Mining total -----	do	\$705	\$909	\$886
Metal mining -----	do	\$39	\$37	\$40
Nonmetallic minerals except fuels -----	do	\$113	\$119	\$97
Coal mining -----	do	\$9	\$8	\$9
Oil and gas extraction -----	do	\$544	\$745	\$741
Manufacturing total -----	do	\$37,098	\$38,408	\$38,869
Primary metal industries -----	do	\$1,134	\$1,014	\$979
Stone, clay, and glass products -----	do	\$935	\$928	\$998
Chemicals and allied products -----	do	\$2,220	\$2,317	\$2,360
Petroleum and coal products -----	do	\$959	\$906	\$731
Construction -----	do	\$8,808	\$10,011	\$11,402
Transportation and public utilities -----	do	\$14,628	\$15,109	\$15,256
Wholesale and retail trade -----	do	\$29,323	\$31,657	\$33,722
Finance, insurance, real estate -----	do	\$23,825	\$26,707	\$31,989
Services -----	do	\$50,343	\$55,686	\$61,006
Government and government enterprises -----	do	\$28,885	\$30,942	\$33,578
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do	44,869	61,927	60,198
Value of nonresidential construction <sup>4</sup> -----	millions	\$2,243.5	\$3,172.1	\$2,849.4
Value of State road contract awards <sup>5</sup> -----	do	\$979.9	\$992.3	\$910.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	2,785	3,284	3,737
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$611.3	\$657.3	\$677.6
Value per capita -----	do	\$35	\$37	\$38

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

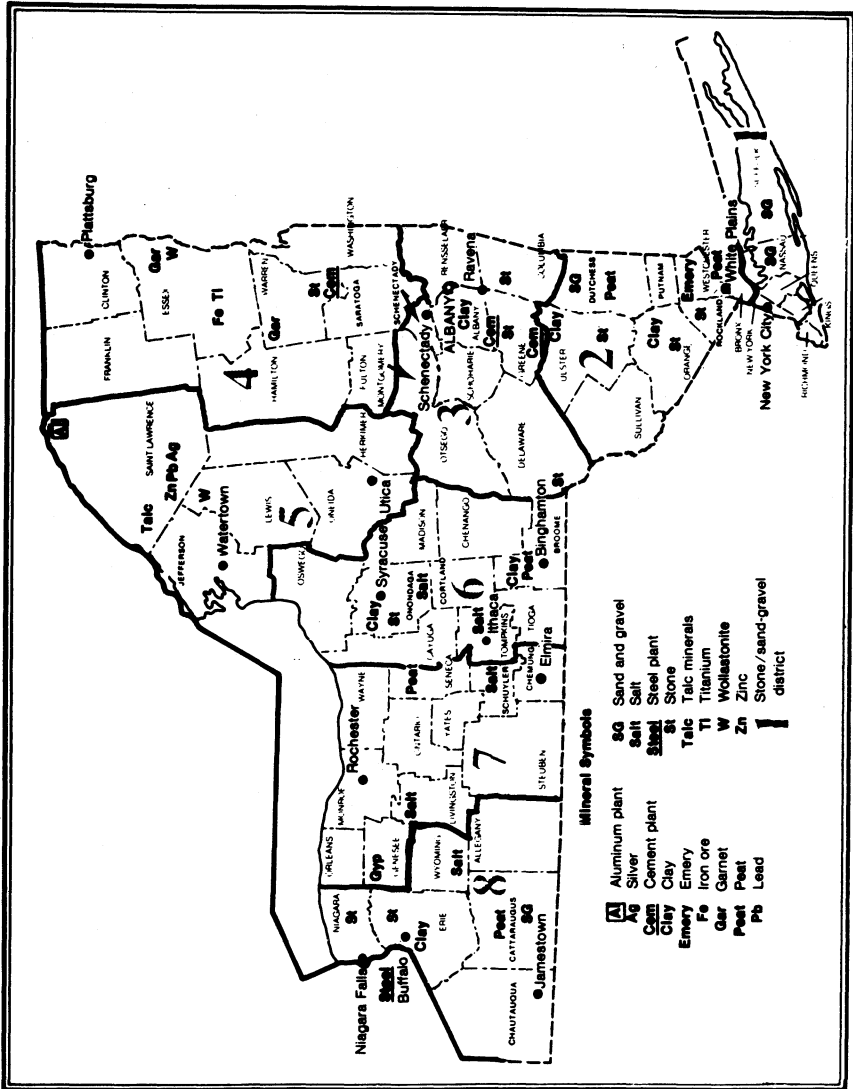


Figure 1.—Principal mineral-producing localities in New York.

The U.S. Bureau of Land Management and the New York State Department of Environmental Conservation entered into an agreement to competitively lease their jointly held mineral interests in the Canadaway Creek Wildlife Management Area in the western part of the State. Lands affected are those settled under the Bankhead-Jones Farm Tenant Act, which conveyed all the surface rights and 25% of the mineral rights to the State. The majority of the mineral rights (75%) was reserved to the United States.

In November, Columbia University's

Henry Krumb School of Mines was selected as a U.S. Bureau of Mines' Mining and Mineral Resource Institute. Columbia joined 31 other universities nationwide that were eligible to receive an annual \$142,000 grant to conduct research and training in minerals-related disciplines. Under the program, the schools match each dollar of the Federal grant with \$2 of their own. The mineral institute program was first authorized by Congress in 1977 (Public Law 95-87, title III) and was later extended through fiscal year 1989 by Public Law 98-409.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Abrasives (Manufactured).**—High-purity fused aluminum oxide was produced by Electro Minerals (U.S.) Inc. (formerly Sohio Electro Minerals Co.) and by General Abrasives Div. of Dresser Industries Inc., both in Niagara Falls. General Abrasives also produced regular fused aluminum oxide. Production of both high-purity and regular fused aluminum oxide were substantially lower in 1986. This decrease was the result of a sharp nationwide drop in demand for abrasives, which were used primarily by the steel, automotive, and other basic industries. Added to this were the longer term trends in materials usage and substitution, and the impact of cheap imports from Europe, which together contributed to overcapacity and low prices.<sup>4</sup>

Cut wire shot used for abrasives was produced by Pellets Inc. at a plant in Tonawanda, Erie County.

**Calcium Compounds (Synthetic).**—In February, Allied Chemical Corp. (now General Chemical Corp.) closed its calcium chloride facility in Syracuse along with its synthetic soda ash plant. The plant was closed because of weak demand and high production costs.

During the year, Pfizer Inc. announced that it planned to construct a precipitated calcium carbonate plant at Ticonderoga. The plant will be operated by Pfizer but will be run in cooperation with the International Paper Co., which has a paper mill in Ticonderoga. The paper mill will supply carbon dioxide, which is a waste product of the pulp processing, which will be used in the precipitation of the calcium carbonate.<sup>5</sup>

**Cement.**—Four companies operated five cement plants in the State. Portland ce-

ment was produced at all five plants, and masonry cement was produced at four of the plants. Portland cement was produced by Atlantic Cement Co. Inc. at Ravena, Independent Cement Corp. at Catskill, Lehigh Portland Cement Co. at Cementon, and Moore McCormack Resources Inc. at Glens Falls and Howe Cove. All of the plants except Moore McCormack's Howe Cove plant and Independent Cement's Catskill plant produced masonry cement. In 1986, shipments and value of portland cement increased 3% and 15%, respectively. Both shipments and value of masonry cement rose more than 40% during the same period.

Lehigh Portland Cement expressed interest in the possibility of burning Green and Columbia Counties' garbage for fuel in its cement kilns. Pellets made from waste would supplement the coal presently being used. A demonstration burn and approval from both the New York Department of Environmental Conservation and local government officials would first be necessary.

New York Cement Co. began selling imported cement from a silo ship anchored at the Brooklyn import terminal to supply cement to the New York metropolitan area.

**Clays.**—In 1986, production of common clay decreased 12% after increasing substantially in the last several years. Common clay was produced by seven companies in six counties. Leading counties in order of output were Albany, Ulster, and Orange. Clay was used principally in the manufacture of portland cement, face brick, and lightweight aggregate for use in structural concrete and block.

**Emery.**—New York was the only State that produced emery. One company, John Leardi Emery Mine, produced emery from a



mine near Peekskill in Westchester County. The material was processed by two out-of-State companies—Washington Mills Abrasive Co., North Grafton, MA, and Fmeri-Crete Inc., New Castle, NH. Emery was used mainly as a nonslip additive for floors, pavements, and stair treads. Minor uses were for coated abrasives and as a tumbling and deburring medium.

**Garnet.**—Of the four domestic garnet producers active in 1986, two were in New York. Barton Mines Corp. operated a surface mine near North Creek, Warren County. The material was used in coated abrasives, glass grinding and polishing, and metal lapping. The NYCO Div. of Processed Minerals Inc. recovered crude garnet concentrate as a byproduct at its wollastonite mining operation. The material was sold to a domestic garnet producer for refinement and sale.

**Gem Stones.**—Value of gem stones and mineral specimens collected by mineral dealers and amateur collectors in New York, based on a survey by the curator of mineralogy of the New York State Museum, was estimated at \$120,000 in 1986. Of this amount, approximately \$84,000 entered the market as specimens and educational-grade samples and \$36,000 remained in private collections and museums. Popular gem- and mineral-collecting areas included Gore Mountain near North Creek, Warren County; sphalerite, galena, and talc refuse areas from mines operating near Balmat, St. Lawrence County; and southern Herkimer County where "Herkimer Diamonds," doubly terminated clear quartz crystals were found. Heightened public interest in the purported healing aspects of quartz has greatly increased the value of these crystals recently.

**Graphite (Synthetic).**—New York ranked first of 16 States that manufactured synthetic graphite. Three companies, all in Niagara County, produced and shipped graphite during the year. Principal uses of the synthetic graphite were for anodes, cathodes, crucible and vessels, electrodes, lubricants, and unmachined graphite shapes.

**Gypsum.**—USG Corp., the State's only producer, mined gypsum from an underground mine at Oakfield in Genesee County. Output of crude gypsum declined almost 2%, but value decreased nearly 23%. Crude gypsum mined at Oakfield and gypsum imported from Canada were calcined and made into wallboard at two company-owned

plants in Oakfield and Stony Point, Rockland County. In terms of total output, the Stony Point plant ranked sixth of 72 plants that calcined gypsum in the United States.

Two other gypsum calcining plants also operated in the State. National Gypsum Co. operated a plant in Rensselaer County and Georgia-Pacific Corp. operated a plant in Buchanan, Westchester County. Although total State output of calcined gypsum remained essentially the same in 1986, value decreased nearly 22%. This decrease in value closely paralleled the national average for calcined gypsum, which fell 15%.

**Iodine.**—Crude iodine was shipped into the State by RSA Corp., Westchester County, and Sterling Organics U.S., Rensselaer County. RSA, the largest processor in New York, produced specialty organic chemicals. Sterling used the iodine for the manufacture of pharmaceuticals, catalysts, and sanitation products.

**Lime.**—In late 1985, Allied Chemical ceased lime production when it shut down the Jamesville Quarry. The quarry also supplied raw feed for the company's Solvay soda ash plant, which closed in 1986.

**Mullite (Synthetic).**—Electric-furnace-fused mullite was produced by Sohio Electro at Niagara Falls. Late in the year, Sohio was purchased by Washington Mills Abrasive, North Grafton, MA, and its name changed to Electro Minerals (U.S.). Mullite produced at the plant was primarily used by the steel industry for furnace linings.

**Peat.**—Four companies produced peat at four operations in Broome, Cattaraugus, Seneca, and Westchester Counties. Both reed sedge and humus were sold for soil improvement and as an ingredient in potting soils.

**Perlite (Expanded).**—Crude perlite shipped in from other States was expanded by Buffalo Perlite Corp., a division of Pine Hill Concrete Mix Corp., Erie County, and by Solite International Corp., Rensselaer County. The expanded perlite was used in lightweight acoustical building plaster, loose fill insulation, soil conditioning, and filtration.

**Salt.**—New York ranked third in the Nation in salt sold or used and second in value, producing 14% of the Nation's total output. In 1986, total salt sold or used (including rock and brine) in New York declined 28% in quantity and 14% in value. The majority of the decrease was the result of lower sales of rock salt; brine output and value declined by only 2%. Rock salt was

produced by Cargill Inc. in Tompkins County and by International Salt Co. in Livingston County. Evaporated salt also was produced by Cargill and International, each operating a plant in Tompkins County, and by Morton Thiokol Inc. and Texas Brine Corp. in Wyoming County. Allied Chemical, which produced brine in 1985, shut down its plant in Onondaga County early in 1986.

In April, approximately 140 unionized workers at Cargill went on strike after rejecting a company contract offer. By year-end, about 50 of the miners crossed the picket line and returned to work. Cargill subsequently hired about 90 workers to replace the striking workers in order to bring employment and production to pre-strike levels.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The value of construction sand and gravel accounted for 15% of the State's total mineral value. In 1986, 366 companies mined construction sand and gravel from 420 oper-

ations in 53 counties. Leading counties in order of output were Suffolk, Rensselaer, Cattaraugus, Dutchess, and Orange. Main uses of the material were for road base and coverings, concrete aggregates, and fill.

The shortage of land-based deposits, coupled with restrictive regulations, renewed interest in offshore mining of construction sand and gravel. In the Greater New York metropolitan area, one of the major aggregate markets in the United States, McCormack Aggregates began offshore mining from the Ambrose Channel between Staten Island and Brooklyn. In 1986, the company produced 1.6 million cubic yards, and it expected to produce between 1.6 and 1.9 million cubic yards of sand and gravel from this channel in 1987.<sup>6</sup>

The U.S. Bureau of Mines published a report that analyzed the market, offshore resources, and the cost of mining construction sand and gravel near seven major coastal cities.<sup>7</sup> One of the more promising areas investigated was the offshore deposits of the New York metropolitan area. The report estimated that it will cost between \$1.82 and \$2.94 per short ton to mine deposits 40 nautical miles away from New York.

**Table 4.—New York: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,970	\$22,359	\$4.50
Plaster and gunitite sands -----	137	756	5.52
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	1,102	4,202	3.81
Asphaltic concrete aggregates and other bituminous mixtures -----	2,159	10,056	4.66
Road base and coverings <sup>1</sup> -----	5,841	15,410	2.63
Fill -----	2,302	4,135	1.80
Snow and ice control -----	1,322	3,688	2.79
Railroad ballast -----	W	W	1.50
Other <sup>2</sup> -----	428	2,041	4.76
Other unspecified <sup>3</sup> -----	12,910	41,102	3.18
<b>Total<sup>4</sup> or average -----</b>	<b>31,172</b>	<b>103,748</b>	<b>3.33</b>

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes roofing granules and data indicated by symbol W.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Table 5.—New York: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	2,393	7,097	1,111	8,195	327	1,153	180	612
Asphaltic concrete aggregates and other bituminous mixtures -----	395	609	443	3,365	79	322	W	W
Road base and coverings <sup>2</sup> -----	W	W	679	2,617	616	1,175	951	1,432
Fill -----	W	W	181	358	531	786	W	W
Snow and ice control -----	26	67	249	1,110	182	352	254	619
Other unspecified <sup>3</sup> -----	1,804	6,540	2,287	8,993	2,519	6,737	1,214	3,222
<b>Total<sup>4</sup></b> -----	<b>4,618</b>	<b>14,313</b>	<b>4,949</b>	<b>24,639</b>	<b>4,254</b>	<b>10,526</b>	<b>2,599</b>	<b>5,885</b>
	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	247	744	848	4,791	382	1,481	724	3,242
Asphaltic concrete aggregates and other bituminous mixtures -----	W	W	517	2,882	103	347	506	2,019
Road base and coverings <sup>2</sup> -----	W	W	997	2,177	1,004	2,165	1,145	4,204
Fill -----	384	515	307	642	130	442	100	169
Snow and ice control -----	201	361	215	525	109	340	87	313
Other unspecified <sup>3</sup> -----	1,127	2,903	1,726	6,273	2,303	7,324	1,592	4,574
<b>Total<sup>4</sup></b> -----	<b>1,958</b>	<b>4,523</b>	<b>4,610</b>	<b>17,241</b>	<b>4,031</b>	<b>12,099</b>	<b>4,153</b>	<b>14,522</b>

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes railroad ballast, roofing granules, other specified uses, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Whitehead Bros. Co. was the only industrial sand producer in New York in 1986. The company operated one pit in Saratoga County and one in Oneida County. Major sales were for glassmaking, moldings, and foundry purposes.

**Slag.—Iron.**—Buffalo Crushed Stone Corp. processed air-cooled iron (blast furnace) slag at a plant in Buffalo. Sales in 1986 increased more than twofold compared with those of 1985. Main uses for slag were for road base, asphaltic concrete aggregate, fill, and railroad ballast.

**Sodium Carbonate (Synthetic).**—Allied Chemical (now General Chemical) permanently closed its synthetic soda ash plant at Syracuse. The plant was the first synthetic soda ash plant built in the United States and the last one to close. With the closing of this plant, Allied Chemical also sold the Jamesville Quarry, which supplied raw material to the plant, to General Crushed Stone Co. for \$8.42 million. General Crushed Stone sold the limestone for construction aggregate.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates

for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Estimated crushed stone production totaled 40.6 million short tons valued at \$196.6 million. Limestone was the leading type of crushed stone produced. Other types included dolomite, granite, sandstone, and traprock. The crushed stone was mainly used for road base, bituminous aggregate, cement manufacture, and fill.

**Dimension.**—The survey of dimension stone producers was not conducted in 1986 since data are collected only for odd-numbered years. The preliminary survey for 1984, which collected production information on a sample basis for the first 9 months only, was used to generate the State's preliminary estimates. Based on these estimates, dimension stone production in 1986 amounted to 15,637 short tons valued at \$3 million. Types of stone quarried were granite, sandstone, and slate.

**Talc.**—New York ranked fourth of nine States that produced talc in 1986. The Gouverneur Talc Co. Inc., a subsidiary of R. T. Vanderbilt Co. Inc., mined the talc from both a surface and an underground oper-

ation. The ore was ground and processed at an on-site mill and used primarily for ceramics and paint additives.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. exfoliated crude vermiculite concentrate shipped in from out of State at its plant in Weedsport, Cayuga County. The exfoliated vermiculite was primarily used for loose fill insulation, block insulation, horticulture, lightweight concrete aggregate, and soil conditioning.

**Wollastonite.**—New York led the Nation in the production of wollastonite, accounting for nearly all of the Nation's output. (A small amount was also produced in California). The wollastonite from New York also accounted for nearly two-thirds of the world's output. Two companies mined wollastonite in the State in 1986. NYCO, a division of Processed Minerals, was the largest producer. The company operated the Lewis surface operation 14 miles west of Willsboro, Essex County. The crushed ore averaged 60% wollastonite and 40% garnet and impurities. The operation covered approximately 30 acres of a 260-acre property and was worked under a permit from the Adirondack Park Agency. A portable 300-short-ton-per-hour crushing unit was employed at the minesite, and the resulting crushed ore was transported 14 miles to a mill at Willsboro for further processing or stockpiling.

Vanderbilt, the State's other producer, operated an underground mine in Lewis County. The mine is near Harrisville and is operated by Vanderbilt's talc mining subsidiary, Gouverneur Talc. The ore differs from that of NYCO material in that garnet is not present in the deposit.<sup>8</sup>

Although production decreased 3% in 1986 compared with that of 1985, value of wollastonite production rose nearly 6%. Major uses of wollastonite are as a filler in ceramic tile, marine wallboard paint, plastics, and refractory liners in steel mills.

## METALS

**Aluminum.**—New York continued to rank second, behind Washington, in both output and value of primary aluminum. Two companies, both in Massena, St. Lawrence County, operated smelters. Reynolds Metals Co. operated a 114,000-metric-ton-per-year smelter at full capacity, and Aluminum Co. of America (Alcoa) operated a 205,000-metric-ton-per-year plant at two-thirds capacity.

In December, Alcoa shut down a second 39,000-metric-ton potline at its Massena plant, reducing the plant's capacity to 127,000 metric tons per year. The reason cited for the closure was the failure to obtain an electricity rate cut from the New York Power Authority. Alcoa indicated earlier that it would keep the second potline running only if it was charged lower rates.

**Iron and Steel.**—In 1986, there were no reported shipments of pig iron from New York. Raw steel production amounted to 541,000 short tons in 1986.

In July, Allegheny Ludlum Steel Corp.'s Special Materials Div. plant in Lockport started production from a newly installed, \$21 million, 18-ton argon oxygen decarburization (AOD) vessel and restarted three 15-ton electric arc furnaces already in place.

Near midyear, Rio Algom Ltd., Toronto, Canada, purchased Al Tech Specialty Steel Corp. in Dunkirk. Rio Algom planned to combine Al Tech's operations with those of its Atlas Steels' Div. in Welland, Ontario, Canada. With the change of ownership, Al Tech will no longer produce primary specialty steels for its finishing operations, resulting in the loss of 400 jobs at Al Tech. Rio Algom's plant will produce specialty steel ingots, billets, forging bars, and rock drill steel, which will be shipped to Al Tech for finishing into specialty bar, rod, wire, extruded shapes, and pipe and tube products.

Crucible Special Metals, a division of Crucible Materials Corp., returned to full production at its Syracuse plant on October 13 after members of the United Steelworkers of America locals voted to ratify a new 3-year contract. The ratification ended a strike that began October 1 when the rank and file union members overwhelmingly rejected a previous contract offer. During the strike, the melt shop was closed but the plant stayed in operation utilizing 400 salaried employees.

**Lead and Silver.**—Lead and silver were recovered as byproducts at St. Joe Resources Co. zinc operations in St. Lawrence County.

**Zinc.**—New York ranked second in the Nation after Tennessee in zinc output, up from third place in 1985. St. Joe Resources, the only producer in the State, operated two mines (Balmat and Pierrepont) and a 3,900-metric-ton-per-day mill at Balmat, St. Lawrence County. In 1986, the Pierrepont Mine was the Nation's second leading zinc mine

in terms of total output; the Balmat zinc mine ranked seventh. Despite a year-long strike at the mines and mill, the facility operated at about 80% capacity utilizing supervisory and nonunion personnel.

Late in the year, the U.S. Department of Labor approved Federal aid for about 600 displaced workers at the mines and mill. The Labor Department noted that all workers who lost their jobs on or after April 2, 1985, were eligible for assistance under the 1974 trade adjustment law because of the increase in zinc concentrate imports.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Senior scientist, New York Geological Survey, Albany, NY.

<sup>3</sup>Coal and Synfuels Technology. NY Tests Cleaning Methods. V. 7, No. 29, Sept. 29, 1986, pp. 5-6.

<sup>4</sup>Toon, S. Abrasive Markets: Hard Work in Soft Markets. Ind. Miner. (London), No. 231, Dec. 1986, pp. 53-71.

<sup>5</sup>Industrial Minerals (London). A Second PCC Satellite. No. 225, June 1986, p. 14.

<sup>6</sup>Roelhepartain, J. L. Offshore Mining May Start in United States. Rock Prod., v. 90, No. 6, June 1987, pp. 33-37.

<sup>7</sup>U.S. Bureau of Mines. An Economic Reconnaissance of Selected Sand and Gravel Deposits in the U.S. Exclusive Economic Zone. BuMines OFR-3-37, 1987, 113 pp.

<sup>8</sup>Power, T. Wollastonite, Performance Filler Potential. Ind. Miner. (London), No. 220, Jan. 1986, pp. 19-34.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives (manufactured):</b>			
Electro Minerals (U.S.) Inc -----	1801 Buffalo Ave. Box 423 Niagara Falls, NY 14302	Plant -----	Niagara.
General Abrasives Div. of Dresser Industries Inc. -----	2000 College Ave. Niagara Falls, NY 14305	do -----	Do.
Pellets Inc -----	531 South Niagara St. Tonawanda, NY 14150	do -----	Erie.
<b>Aluminum (primary):</b>			
Aluminum Co. of America -----	1210 Alcoa Bldg. Pittsburgh, PA 15222	Smelter -----	St. Lawrence.
Reynolds Metals Co. -----	Box 27003-2A Richmond, VA 23215	do -----	Do.
<b>Cement:</b>			
Atlantic Cement Co. Inc., a subsidiary of Newmont Mining Corp. <sup>1 2</sup> -----	Box 3 Ravena, NY 12143	Quarry and plant.	Albany.
The Glens Falls Portland Cement Co. Inc., a subsidiary of Moore McCormack Resources Inc. <sup>1</sup> -----	Box 440 Glens Falls, NY 12801	Quarries and plants.	Schoharie and Warren.
Independent Cement Corp -----	Box 12-310 Albany, NY 12212	Quarry and plant.	Greene.
Lehigh Portland Cement Co. <sup>1</sup> -----	718 Hamilton Mall Allentown, PA 18105	do -----	Do.
<b>Clays:</b>			
Norlite Corp., a subsidiary of P. J. Keating Co. -----	Box 367 Fitchburg, MA 01420	Pit -----	Albany.
Northeast Solite Corp., a subsidiary of Solite Corp. -----	Box 27211 Richmond, VA 23261	Pit -----	Ulster.
Powell & Minnock Brick Works Inc -----	Route 144 Coeymans, NY 12045	Pit -----	Do.
<b>Emery:</b>			
John Leardi Emery Mine -----	Gillman Lane Peekskill, NY 10566	Pit -----	Westchester.
<b>Garnet:</b>			
Barton Mines Corp -----	North Creek, NY 12853	Pit -----	Warren.
<b>Gypsum:</b>			
<b>Calcined:</b>			
Georgia-Pacific Corp -----	Box 105605 133 Peachtree St., NE. Atlanta, GA 30348	Plant -----	Westchester.
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	do -----	Rensselaer.
<b>Crude:</b>			
USG Corp -----	101 South Wacker Dr. Chicago, IL 60606	Underground mines and plants.	Genesee and Rockland.
<b>Iron ore:</b>			
NL Chemicals Inc. -----	Tahawus, NY 12879	Pit -----	Essex.
<b>Lime:</b>			
Allied Chemical Corp. <sup>2 3</sup> -----	Box 70 Morristown, NJ 07960	Quarry and plant.	Onondaga.
<b>Peat:</b>			
Good Earth Organics Corp -----	5960 Broadway Lancaster, NY 14086	Bog -----	Cattaraugus.
<b>Perlite (expanded):</b>			
Buffalo Perlite Corp -----	100 Sugg Rd. Buffalo, NY 14225	Plant -----	Erie.
Solite International Corp -----	6 Madison St. Troy, NY 12181	do -----	Rensselaer.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Salt:</b>			
Cargill Inc -----	Box 5621 Minneapolis, MN 55440	Underground mine.	Tompkins.
International Salt Co. -----	Clarks Summit, PA 18411	Underground mines.	Livingston and Schuyler.
Morton Thiokol Inc. -----	110 North Wacker Dr. Chicago, IL 60606	Well -----	Wyoming.
<b>Sand and gravel:</b>			
Broad Hollow Estates Inc -----	Box 483 Farmingdale, NY 11735	Pit -----	Suffolk.
Buffalo Crushed Stone Inc. -----	2544 Clinton St. Buffalo, NY 14224	Pits -----	Cattaraugus.
McCormack Sand Co -----	Box 448 Port Washington, NY 11050	Pit -----	Nassau.
<b>Slag—iron:</b>			
Buffalo Crushed Stone Corp. <sup>2</sup> -----	2544 Clinton St. Buffalo, NY 14216	Plant -----	Erie.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
Callahan Industries Inc -----	South St. South Bethlehem, NY 12161	Quarries -----	Albany, Madison, Rensselaer, Ulster.
Dolomite Products Inc -----	1150 Penfield Rd. Rochester, NY 14625	-----do -----	Genesee and Ul- ster.
The General Crushed Stone Co., a subsidiary of Koppers Co. Inc. -----	Box 231 Easton, PA 18042	-----do -----	Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne.
New York Trap Rock Corp., a subsid- iary of Lone Star Industries Inc. -----	Box 432 Montvale, NJ 07645	Quarry -----	Rockland.
Peckham Materials Corp. -----	20 Haarlem Ave. White Plains, NY 10603	Quarries -----	Greene, Putnam, Warren, Washington.
Tilcon Quarries Inc -----	Box 362 Haverstown, NY 10927	-----do -----	Rockland and Ulster.
<b>Dimension:</b>			
Finger Lakes Stone Co. Inc -----	Box 401 Ithaca, NY 14850	Quarry -----	Tompkins.
Heldeberg Bluestone & Marble Co --	Box 36 East Berne, NY 12059	Quarries -----	Albany and Delaware.
Hilltop Slate Co -----	Middle Granville, NY 12849	Quarry -----	Washington.
Johnson & Rhodes Bluestone Co -----	East Branch, NY 13756	-----do -----	Delaware.
Lake Placid Granite Co., a division of Cold Springs Granite Co. -----	202 South 3d Ave. Cold Spring, MN 56320	-----do -----	Essex.
Northern Adirondack Quarries -----	86 Catherine St. Malone, NY 12953	-----do -----	Franklin.
Ritchie Bros. Slate Co. Inc -----	Main St. Middle Granville, NY 12849	Quarries -----	Washington.
<b>Talc:</b>			
Gouverneur Talc Co. Inc., a subsidiary of R. T. Vanderbilt Co. Inc. -----	Box 89 Gouverneur, NY 13642	Underground mine.	St. Lawrence.
<b>Vermiculite:</b>			
W. R. Grace & Co -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Cayuga.
<b>Wollastonite:</b>			
NYCO Div. of Processed Minerals Inc ---	Box 368 Willboro, NY 12996	Surface mine --	Essex.
R. T. Vanderbilt Co. Inc -----	30 Winfield St. Norwalk, CT 06855	Underground mine.	Lewis.
<b>Zinc:</b>			
St. Joe Resources Co. <sup>4</sup> -----	250 Park Ave. New York, NY 10017	Underground mines.	St. Lawrence.

<sup>1</sup> Also clays.<sup>2</sup> Also stone.<sup>3</sup> Also salt.<sup>4</sup> Also byproduct lead and silver.



# The Mineral Industry of North Carolina

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

By Doss H. White, Jr.,<sup>1</sup> and P. Albert Carpenter III<sup>2</sup>

In 1986, North Carolina's mineral producers reported sales and/or stockpiled mineral value totaling \$466.4 million. This eclipsed the 1985 record-high for the value of mineral output by \$1 million.

The value and tonnage of 12 of the 15 mineral commodities extracted in North Carolina equaled or exceeded 1985 levels. Lithium minerals, talc and pyrophyllite, and phosphate rock values were below those

reported for 1985.

Some segments of the State's mineral industry were affected by foreign mineral imports, and two firms terminated operations as a result of import competition. Despite the influx of cheap foreign minerals, North Carolina continued to lead the Nation in the production of feldspar, lithium minerals, scrap mica, olivine, and pyrophyllite.

Table 1.—Nonfuel mineral production in North Carolina<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	2,327	\$8,987	2,688	\$10,477	2,658	\$10,970
Feldspar ----- short tons	510,275	13,994	490,993	13,351	526,672	15,568
Gem stones -----	NA	*50	NA	*50	NA	551
Gold (recoverable content of ores, etc.)						
----- troy ounces	--	--	--	--	12	4
Mica (scrap) ----- thousand short tons	79	3,762	80	3,726	89	4,641
Peat ----- do	W	W	W	W	15	W
Sand and gravel:						
Construction ----- do	6,312	18,159	*6,100	*19,500	7,543	23,127
Industrial ----- do	1,158	12,864	1,294	13,086	1,464	16,656
Stone:						
Crushed ----- do	*38,100	*168,000	41,771	194,818	*43,500	*206,500
Dimension ----- do	r *35	r *5,970	35	6,132	*41	*6,633
Talc and pyrophyllite ----- do	87	1,587	85	1,604	83	1,552
Combined value of lithium compounds, olivine, phosphate rock, and values indicated by symbol W	XX	r 215,897	XX	r 202,642	XX	180,221
Total -----	XX	r 449,270	XX	r 465,386	XX	466,423

\*Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



Table 2.—Nonfuel minerals produced in North Carolina in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Alamance	Stone (crushed), clays.
Anson	Sand (industrial), stone (crushed).
Ashe	Stone (crushed).
Avery	Stone (crushed), mica, clays.
Beaufort	Phosphate rock.
Buncombe	Stone (crushed).
Burke	Do.
Cabarrus	Stone (crushed), clays.
Caldwell	Stone (crushed).
Caswell	Do.
Catawba	Do.
Chatham	Clays.
Cherokee	Stone (crushed), stone (dimension), pyrophyllite.
Cleveland	Lithium, stone (crushed), feldspar, clays, mica.
Craven	Stone (crushed).
Davidson	Stone (crushed), stone (dimension), clays.
Davie	Stone (crushed).
Duplin	Do.
Durham	Stone (crushed), clays.
Edgecombe	Stone (crushed).
Forsyth	Do.
Gaston	Lithium, stone (crushed), feldspar, mica.
Guilford	Stone (crushed), clays.
Halifax	Clays.
Harnett	Stone (crushed), sand (industrial), clays.
Haywood	Stone (crushed).
Henderson	Stone (crushed), clays.
Hyde	Peat.
Iredell	Stone (crushed), clays.
Jackson	Olivine, stone (crushed).
Johnston	Stone (crushed).
Jones	Do.
Lee	Stone (crushed), clays.
McDowell	Stone (dimension).
Macon	Stone (crushed).
Mecklenburg	Do.
Mitchell	Feldspar, mica, stone (crushed), olivine, stone (dimension).
Montgomery	Stone (dimension), clays.
Moore	Pyrophyllite, clays.
New Hanover	Stone (crushed).
Onslow	Do.
Orange	Stone (crushed), pyrophyllite.
Pender	Stone (crushed).
Pitt	Do.
Polk	Stone (dimension).
Randolph	Stone (crushed).
Richmond	Sand (industrial), stone (crushed).
Rockingham	Stone (crushed), clays.
Rowan	Stone (crushed), clays, stone (dimension).
Rutherford	Stone (crushed).
Sampson	Clays.
Stanly	Do.
Stokes	Do.
Surry	Stone (dimension), stone (crushed).
Swain	Stone (crushed).
Transylvania	Do.
Union	Stone (crushed), clays.
Vance	Stone (crushed).
Wake	Stone (crushed), clays.
Washington	Peat.
Watauga	Stone (crushed), stone (dimension).
Wilkes	Stone (crushed).
Wilson	Do.
Yancey	Olivine, mica.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of North Carolina business activity

		1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Employment and labor force, annual average:</b>				
Population	thousands	6,170	6,262	6,333
Total civilian labor force	do.	3,031	3,121	3,194
Unemployment	percent	6.7	5.4	5.3
<b>Employment (nonagricultural):</b>				
Mining total	thousands	4.6	4.8	4.7
Manufacturing total	do.	835.6	828.6	831.9
Primary metal industries	do.	10.6	10.6	11.2
Stone, clay, and glass products	do.	19.1	19.4	20.4
Chemicals and allied products	do.	38.4	37.6	37.6
Petroleum and coal products <sup>1</sup>	do.	.7	.7	.8
Construction	do.	132.6	149.2	157.3
Transportation and public utilities	do.	126.6	130.5	133.1
Wholesale and retail trade	do.	548.9	576.2	607.1
Finance, insurance, real estate	do.	103.8	109.4	118.4
Services	do.	399.3	428.7	452.5
Government and government enterprises	do.	413.7	420.5	426.7
<b>Total<sup>2</sup></b>	<b>do.</b>	<b>2,565.2</b>	<b>2,651.2</b>	<b>2,731.7</b>
<b>Personal income:</b>				
Total	millions	\$67,881	\$73,171	\$78,763
Per capita		\$11,001	\$11,685	\$12,438
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		39.9	39.6	40.7
Mining		42.7	46.5	45.5
Total average hourly earnings, production workers		\$7.0	\$7.3	\$7.5
Mining		\$7.7	\$8.0	\$8.2
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$1,509	\$1,282	\$1,342
Nonfarm	do.	\$50,601	\$54,954	\$59,450
Mining total	do.	\$188	\$242	\$244
Manufacturing total	do.	\$16,049	\$16,617	\$17,723
Primary metal industries	do.	\$299	\$283	\$308
Stone, clay, and glass products	do.	\$409	\$440	\$477
Chemicals and allied products	do.	\$1,035	\$1,078	\$1,183
Petroleum and coal products	do.	\$20	\$21	\$23
Construction	do.	\$3,215	\$3,750	\$4,170
Transportation and public utilities	do.	\$3,592	\$3,824	\$4,055
Wholesale and retail trade	do.	\$8,377	\$9,274	\$9,976
Finance, insurance, real estate	do.	\$2,140	\$2,391	\$2,844
Services	do.	\$3,164	\$9,151	\$10,033
Government and government enterprises	do.	\$8,664	\$9,459	\$10,125
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup>		63,037	70,727	62,995
Value of nonresidential construction <sup>4</sup>	millions	\$1,632.5	\$2,076.2	\$2,014.1
Value of State road contract awards <sup>5</sup>	do.	\$403.5	\$380.0	\$412.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,948	2,034	2,244
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$449.3	\$465.4	\$466.4
Value per capita		\$73	\$74	\$74

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—During the first half of the past decade (1977-86), mineral value and sales rose steadily from \$232 million in 1977 to \$433 million in 1981. In 1982, recessionary effects in many segments of the mineral industry decreased mineral value by \$134 million; however, a recovery followed and mineral value reached a record high \$451 million in 1984. In 1985, value rose slightly, although there was increased competition from foreign mineral compa-

nies, competition that forced two of the State's mineral producers out of business in 1986.

**Exploration Activities.**—Cominco American Incorporated delineated a mineralized zone contiguous with the previously developed ore body at the Howie gold property. Inferred reserves were estimated at 174,000 tons grading 0.25 ounce of gold per ton. During the year, Pacific Minesearch acquired a joint venture interest in the project.

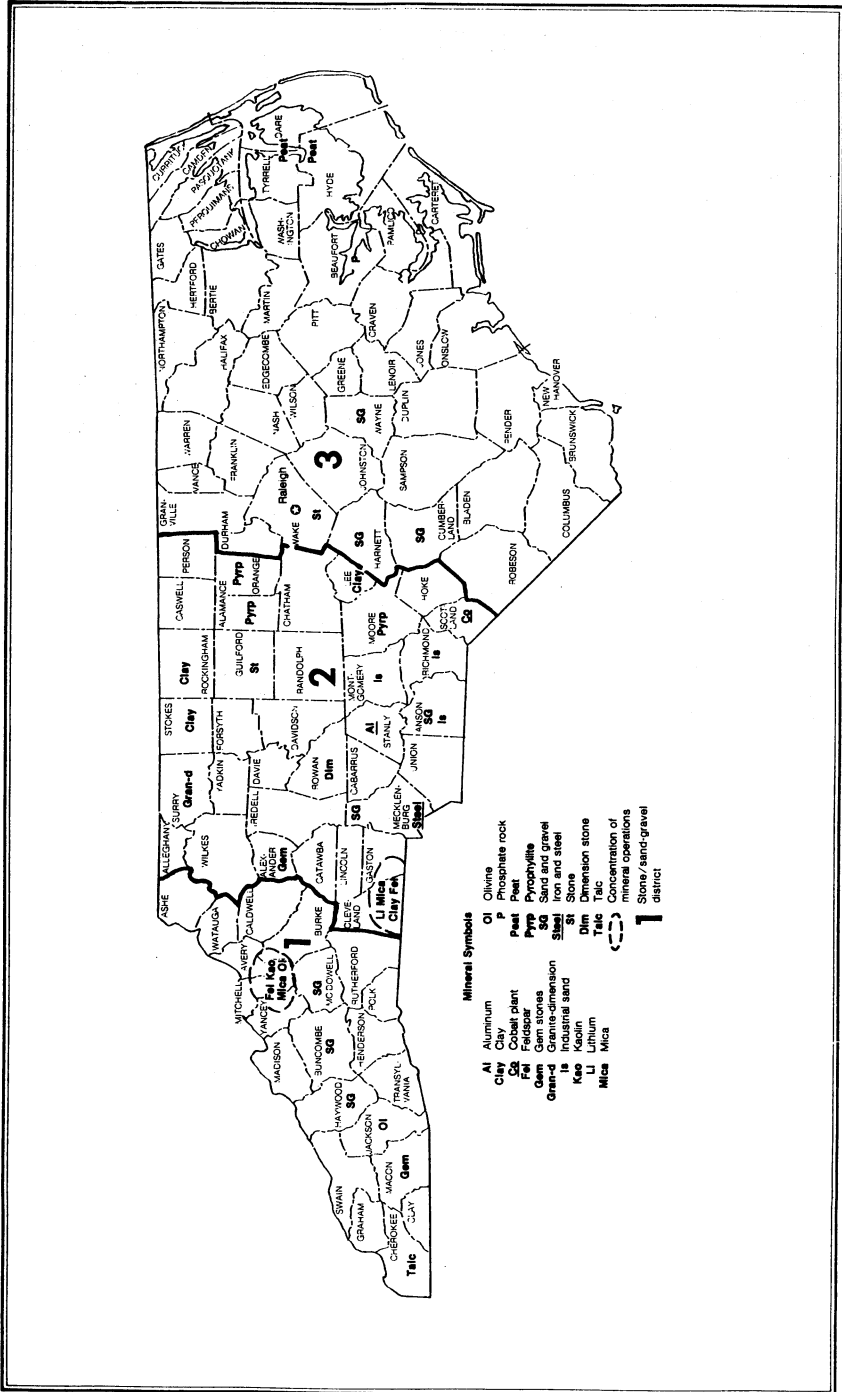


Figure 1.—Principal mineral-producing localities in North Carolina.

**Legislation and Government Programs.**—The North Carolina Geological Survey, a section of the Division of Land Resources, mapped the Sandymush and Canton 7.5-minute quadrangles as part of the effort to locate a high-level radioactive waste repository in the Eastern United States, assisted the North Carolina Department of Administration in a study to determine the feasibility of locating the Superconducting Super Collider in North Carolina, and published a "Geologic Map of North Carolina."

The Land Quality Section, also a section of the Division of Land Resources, administered the "State Mining Act." During the year, the section permitted 74 new mines. Total area affected by mining in North Carolina was approximately 20,770 acres with approximately 723 acres reclaimed during 1986.

The North Carolina Mining Commission

provided a \$10,000 grant to Western Carolina University to conduct a workshop on mineral resources for earth science teachers. The commission funds were obtained from civil penalty monies collected from mining violations.

The Office of Surface Mining, U.S. Department of the Interior, spent approximately \$30,000 during 1986 on projects to seal airshafts and slopes of three abandoned coal mines in Chatham, Lee, and Moore Counties.

The Department of the Interior and the State of North Carolina formed a joint Federal-State task force to evaluate the economic potential and environmental impact of ocean mining for the recovery of phosphorite and other nonfuel minerals in North Carolina's Exclusive Economic Zone (EEZ). The EEZ is an area extending seaward 200 miles from all U.S. coasts and includes both Federal and State waters.<sup>3</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

North Carolina ranked 12th nationally in the production of industrial minerals. At yearend, 360 firms were permitted to operate 640 mines to produce 15 industrial minerals.

**Boron.**—PPG Industries Inc. imported colemanite and ulexite, both borate minerals mined in Turkey and ground to specifications by Industrial Minerals Inc. at a plant in Kings Creek, SC. PPG also purchased boric acid from California. The borates were used in fiberglass manufacture at the company's plants in Lexington and Shelby.

**Cement.**—Atlantic Cement Co. (ACC), owned by Blue Circle PLC, operated a 675-ton distribution terminal in Durham that served the central and eastern State markets and portions of Virginia.

**Clays.**—North Carolina's clay industry dates from the 1700's when Josiah Wedgwood shipped 5 tons of kaolin to England for jasperware manufacture. From this meager beginning, the State's clay industry has grown to a multimillion-dollar-per-year business, and during the decade of the 1980's, over 16 million tons valued at \$56 million has been produced. In 1986, the clay industry in North Carolina consisted of 20 companies operating 48 pits in 22 counties.

Common clay and shale was mined by 18 companies at 46 pits in 19 counties, and 2

companies recovered kaolin during mica beneficiation at sites in Avery and Cleveland Counties.

The majority of the common clay and shale used in the manufacture of brick was from a 13-county area in the central area of the State where raw materials were residual clays developed from weathering of the Carolina Slate Belt strata. A lesser amount of clays was produced from weathered Triassic shales in Lee and Moore Counties in central North Carolina. Clays were also mined in (1) Henderson County and (2) Sampson, Halifax, and Harnett Counties, the former in the southwest and the latter in the eastern part of the State.

Historically, North Carolina has been the Nation's leading State in the manufacture of brick; this was again true in 1986 with 19 firms manufacturing brick. Jannock Ltd., Canada, acquired Borden Clay Products Co. of Greensboro,<sup>4</sup> and Jim Walter Corp. purchased Cherokee Brick Co., Raleigh, and Sanford Brick Co., Sanford.<sup>5</sup>

Kaolin was recovered as a coproduct of mica beneficiation by Unimin Corp. at a plant in Avery County near Spruce Pine, and by KMG Minerals Inc., formerly Kings Mountain Mica Co. Inc., at a plant near Kings Mountain in Cleveland County. Kaolin sales were to the ceramics, china insulator, and specialty brick industries.

**Feldspar.**—For several decades, the State has led the Nation in the output of feldspar,

an anhydrous aluminum silicate necessary for the manufacture of glass and ceramics. In 1986, production increased almost 36,000 short tons over the 1985 total. This was due primarily to the increase in construction activity and in demand for glass and white-ware products.

Three producers in the Spruce Pine District recovered feldspar by flotation of alaskite ore mined by open pit methods. Two companies in the Kings Mountain-Gastonia area recovered a feldspar-silica concentrate during the beneficiation of spodumene, a lithium mineral; and a third company in the Kings Mountain area recovered a feldspar concentrate as a coproduct of mica, kaolin, and silica beneficiation.

In October, International Minerals & Chemical Corp. (IMC) was purchased by Applied Industrial Minerals Corp. (AIMCOR). In November, Unimin agreed to pur-

chase the former IMC feldspar-silica operation from AIMCOR.

Sales, as reported to the Bureau of Mines, were for the manufacture of glass and ceramic products, for enamel, as fillers, and for miscellaneous uses.

**Gem Stones.**—North Carolina continued to rank first in the Eastern United States in the mining and marketing of gem stones and mineral specimens. Several dozen small commercial mining operations in the western and southwestern part of the State provided the opportunity for the hobbyist to collect a variety of precious and semiprecious gem specimens. During the year, a Florida resident found an apple-sized pink sapphire weighing 1,051 carats.

Principal gem stones and gem stone areas in the western part of North Carolina are as follows:

County	Nearest City	Principal gem stones
Alexander	Hiddenite	Emeralds and hiddenite.
Macon	Franklin	Rubies, sapphires, garnets.
Mitchell	Spruce Pine	Emeralds and aquamarine.

**Graphite (Synthetic).**—Great Lakes Carbon Corp., a subsidiary of Horsehead Industry Inc., produced anodes, electrodes, unmachined shapes, and bulk graphite materials at a plant at Morganton in Burke County in the western part of the State. Petroleum coke and pitch, a refinery byproduct, were ground, sized, heated, and extruded. The extruded material was fired and heated at an elevated temperature in an electric resistance oven to produce a synthetic graphite product.

**Gypsum.**—National Gypsum Co. operated a wallboard manufacturing plant in Wilmington. Nova Scotia gypsum, obtained from company-owned mines, was the basic raw material.

Texasgulf Inc. produced a byproduct gypsum during fertilizer manufacture at its complex at Lee Creek. A limited tonnage was sold to local farmers as a soil conditioner. Over the life of the operation a large tonnage has been stockpiled, and in the mid-1980's, the company developed a system to blend the gypsum with clay to create a material used to backfill mined-out pits.

Republic Gypsum Co., a Texas manufacturer of gypsum wallboard, acquired options on 150 acres in Bladen County and announced plans to build a \$20 million wallboard plant. Raw material would be shipped from a Republic mine in Nova Scotia, Canada, through the State port at Wilmington.

**Lithium.**—Although North Carolina continued to lead the Nation in lithium mineral production, output was several thousand tons below the record. Foote Mineral Co. at Kings Mountain and Lithium Corp. of America (Lithcoa) at Cherryville mined spodumene-rich pegmatites by open pit methods. Beneficiation steps included size reduction, flotation, acid roast and leach, purification, and precipitation. Commercial amounts of feldspar, mica, and silica were recovered during beneficiation. The principal end product was lithium carbonate used as a feedstock to produce a variety of lithium products. Lithcoa also produced lithium metal.

Lithium carbonate from the Foote operation was shipped to company plants in Sunbright, VA, Frazer, PA, and New Johnsonville, TN, for lithium chemical manufacture. The remainder was sold on the open market, as was Lithcoa's production. Major users were the aluminum, glass, and grease industries.

In July, the board of directors of Foote announced that the company was for sale at the direction of Newmont Mining Corp., which owns 87.5% of Foote's common stock and 55.5% of its preferred stock. At year-end, the company was still on the market.<sup>6</sup>

**Mica.**—North Carolina's mica production accounted for 65% of the value and 60% of the tonnage produced in the United States.

Industry reports indicated that production and value increased 9,000 short tons and \$915,000, respectively, over production and value reported in 1985. Both wet- and dry-ground mica products were produced; the former was used in the manufacture of cosmetics, paint, and plastics, and the latter was used in joint cement, wallboard, and oil-well-drilling mud. Several companies processed mica purchased from other sources, and two firms fabricated mica shapes.

In February, Unimin Corp. purchased Harris Mining Co. from Blue Diamond Coal Co. for a reported \$3.1 million. At that time, Unimin announced an expansion to double the output of the Harris plant. However, later in the year, a company spokesperson noted that the expansion was postponed. In December, Kings Mountain Mica changed its name to KMG Minerals, and the company purchased the Kings Mountain mica grinding plant of USG Corp.

Table 4.—North Carolina: Mica industry in 1986

Company	Location	Grinding process	Comments
<b>Producers:</b>			
<b>Mica:</b>			
Deneen Mica Co. -----	Micaville -----	Dry -----	Primary mica.
The Feldspar Corp. -----	Spruce Pine -----	XX -----	Byproduct mica; sold to USG Corp.
Foote Mineral Co. -----	Kings Mountain -----	XX -----	Byproduct mica; sold to Asheville Mica Co.
J. M. Huber Corp. -----	Bakersville -----	Wet -----	Processes mica from company's Kings Mountain Mine.
KMG Minerals Inc. -----	Kings Mountain -----	Dry and wet -----	Primary mica.
Indusmin Inc. -----	Spruce Pine -----	XX -----	Byproduct mica; sold to Unimin Corp. (mica).
Lithium Corp. of America Inc. -----	Cherryville -----	XX -----	Byproduct mica; sold to KMG Minerals Inc.
Unimin Corp. (mica) -----	Avery County near Spruce Pine. -----	Dry -----	Primary mica and mica purchased from Deneen.
Unimin Corp. (silica) -----	Mitchell County near Spruce Pine. -----	XX -----	Byproduct mica shipped to Unimin Corp. (mica).
<b>Sericite:</b>			
Piedmont Minerals Co. -----	Hillsboro -----	XX -----	Sold to brick and ceramics industries.
<b>Processors of purchased mica:</b>			
Asheville Mica Co. -----	Asheville -----	Dry -----	Mica purchased from USG Corp. and Foote Mineral Co.
Franklin Mineral Co. -----	Franklin -----	Wet -----	Mica received from Georgia affiliate.
KMG Minerals Inc. <sup>1</sup> -----	Kings Mountain -----	Dry -----	KMG primary mica.
USG Corp. -----	Spruce Pine -----	Dry -----	Mica purchased from Feldspar Corp.
<b>Fabricators:</b>			
Spruce Pine Mica Co. -----	do -----	XX -----	Mica obtained from foreign sources.
Tar Heel Mica Co. -----	Plumtree -----	XX -----	Do.

XX Not applicable.

<sup>1</sup>Formerly USG Corp. plant.

**Monazite.**—In 1986, M & M Minerals Inc., an industrial sand producer, installed separation equipment to produce monazite and other heavy mineral sands as a byproduct. Initial tests produced lower recovery than was anticipated; however, testing continued.

**Olivine.**—North Carolina's olivine industry, once the leading magnesium silicate producer in the Nation, has fallen on hard times. In 1984, three companies mined and processed olivine; at yearend 1986, one re-

mained and it had changed owners.

National Olivine Co., Dillsboro, terminated operations in the fall of 1984. In 1986, Spruce Pine Olivine Co. closed when Norwegian imports were priced under the company's selling price. Spruce Pine Olivine's major customer was in the St. Louis, MO, area, and the Norwegian firm could ship olivine by freighter from Norway to New Orleans, LA, and by barge to St. Louis cheaper than Spruce Pine Olivine could ship by rail.

In November, AIMCOR's (formerly owned by IMC) olivine operations were sold to Unimin along with the feldspar-silica operations.

**Phosphate Rock.**—North Carolina continued to rank second behind Florida in phosphate rock production. Texasgulf operated a mine, beneficiation, and manufacturing facilities at Lee Creek on the Atlantic coast.

Early in the year, the Marion 8200 dragline, obtained when Texasgulf purchased the North Carolina Phosphate Corp. (NCPC), was "walked" 2 miles from the former NCPC Phosphate site to Texasgulf's mining operation. During the year, the company continued work on assembling the bucket wheel excavators, which will replace draglines currently used to remove the upper 40 feet of overburden.

At yearend, the company was assessed \$5.7 million in fines for air pollution violations from 1983 to 1986. Company officials denied that air quality standards had been willfully violated.<sup>7</sup>

**Pyrophyllite.**—North Carolina and California were the two States with pyrophyllite production in 1986. In North Carolina, three companies mined the hydrous aluminum silicate in Moore and Orange Counties. Two companies in Moore County produced a pyrophyllite product used as an insecticide filler and carrier, wallboard, and latex foam filler. The Orange County operation produced an andalusite pyrophyllite used in refractory applications.

**Sand and Gravel.**—In 1986, sand and gravel was the fourth ranked mineral commodity in terms of value and tonnage produced in North Carolina. During the 1980's industry sales have totaled over \$140 million.

**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

**Table 5.—North Carolina: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	2,719	\$8,591	\$3.16
Plaster and gunit sands -----	194	506	2.61
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	65	113	1.74
Asphaltic concrete aggregates and other bituminous mixtures -----	1,300	5,494	4.23
Road base and coverings -----	300	1,085	3.45
Fill -----	330	534	1.62
Snow and ice control -----	3	11	3.67
Other -----	32	102	3.19
Other unspecified <sup>1</sup> -----	2,600	6,741	2.59
Total or average -----	7,543	23,127	3.07

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Table 6.—North Carolina: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	151	541	877	2,391	1,950	6,278
Asphaltic concrete aggregates, and other bituminous mixtures <sup>2</sup> -----	233	945	542	2,924	741	2,409
Fill -----	3	16	21	47	305	471
Other -----	8	56	—	—	24	46
Other unspecified <sup>3</sup> -----	742	2,467	1,125	2,537	736	1,747
Total <sup>4</sup> -----	1,137	4,026	2,565	7,898	3,757	10,952

<sup>1</sup>Includes plaster and gunit sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road base and coverings. Excludes 84,000 short tons valued at \$252,000 not reported by county.

<sup>3</sup>Includes snow and ice control, production reported without a breakdown by end use, and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

The construction sand and gravel sector was composed of 93 companies that operated 124 mines in 42 counties. Leading counties were Harnett, Anson, Cumberland, and Moore in the south-central part of the State and Buncombe County in western North Carolina. The Anson-Richmond County area has one of the largest sand and gravel reserves in North Carolina. Material from this area was shipped to many parts of the State and into South Carolina. As in past years, principal sales were for concrete aggregate, asphaltic concrete, and fill.

**Industrial.**—North Carolina ranked sixth among the 39 States reporting industrial sand and gravel production. The industrial sand industry consisted of six companies and was centered in Anson and Richmond Counties. The two-county contiguous area produced approximately 87% of the State's tonnage. Principal sales were to the container and flat glass industries.

Additional tonnages of industrial sand not included in the table 1 production and value data were produced in Avery, Mitchell, and Yancey Counties as a coproduct of feldspar processing and from lithium processing in Cleveland County.

Unimin purchased AIMCOR's feldspar-quartz operation, purchased from IMC earlier in the year. The quartz was processed into a high-value silica product used in microchips, transistors, and quartz light-

ing.<sup>5</sup>

The Feldspar Corp. continued work on its \$7.25 million facility to produce high-value silica products. This plant is scheduled for completion in the fall of 1987.

**Slag.**—**Iron and Steel.**—The State's single steel mill in Charlotte, operated by Florida Steel Corp., produced a byproduct slag. The slag was marketed for aggregate applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

The U.S. Bureau of Mines stone production estimate for North Carolina for 1986 totaled 43.5 million short tons, an increase of approximately 1.7 million short tons over the 1985 figure.

During the 1980's, stone has been the State's leading mineral commodity in terms of value. Stone sales have risen for the last 4 years, with the 1986 figure a new State record high.

**Crushed.**—The year was not without controversies over the proposed development of new quarries in several areas of the State. Selected quarries in the planning-permitting stage during 1986 are summarized below:

Company	County	Remarks
Martin Marietta Corp., Aggregates Div.	Cabarrus	Proposed quarry on Flowers Store Road.
Do	Iredell	Expanding an existing quarry.
Do	Craven	Proposed quarry at Clarks.
Martin Marietta Corp. and Salem Stone Co.	Forsyth	Proposed quarry near intersection of Highway 311 and High Point Road.
Salem Stone Co.	Davidson	Proposed quarry near Union Cross.
Vulcan Materials Corp.	Cabarrus	Proposed quarry near Poplar Tent Community.

Early in the year, Martin Marietta Corp. shipped the first load of stone from the Benson Quarry in eastern North Carolina.

**Dimension.**—The State ranked 23d out of 36 States in the quarrying and finishing of

dimension stone. In 1985, 8 companies operated 12 quarries in a 9-county area. Dimension stone production is summarized below:

County	Company	Stone type
Cherokee	Moretti-Harrah Marble Co.	Marble.
Davidson and Montgomery	Jacob's Creek Stone Co.	Slate (argillite).
McDowell, Polk, Watauga	O. J. Wilson Stone Co.	Sandstone.
Mitchell	Boone Stone Co.	Granite.
Rowan	Florida Crushed Stone Co.	Do.
Do	Nickville Granite Co. Inc.	Do.
Do	L. S. Starrett Co.	Do.
Surry	North Carolina Granite Corp.	Do.



**Talc.**—The Warner Corp. in Murphy mined talc from deposits associated with the Murphy marble. At yearend, competition from foreign imports forced the company to terminate mining operations, thus closing the last underground mine in the State.

The company planned to use the mill for custom grinding and also to manufacture synthetic talc crayons using a process devel-

oped by Asheville Minerals Laboratory.

## METALS

Although no metallic ores were mined instate in 1986, a variety of metallic raw materials or semiprocessed metallic products were shipped into the State for processing to a finished, higher value product, as shown below:

Commodity	Company	Location	Remarks
Aluminum	Aluminum Co. of America	Badin	115,000-metric-ton-per-year smelter.
Chromium	Diamond Shamrock Chemical Co.	Castle Hayne	1 of 2 chrome chemical plants in the United States.
Cobalt	Carolmet Inc	Laurensburg	Only powdered cobalt plant in the United States.
Copper	SCM Co., Glidden Metals Div.	Durham	Powdered copper.
Lithium	Footo Mineral Co	Kings Mountain	Lithium metal.
Do	Lithium Corp. of America	Cherryville	Do.
Silver	E. I. du Pont de Nemours & Co. Inc.	Arden	Silver emulsions separated from film waste.
Steel	Florida Steel Co	Charlotte	2-furnace minimill.
Titanium	Teledyne Allvac	Monroe	Titanium alloys for the aerospace and biomedical industries.

Kobe Development Corp., a subsidiary of Kobe Steel Ltd., opened a facility in Charlotte for research and development in new materials and steelmaking technology.

Interior Department Announce Joint Task Force To Study Nonfuel Minerals Offshore. Press release, Mar. 12, 1986.

<sup>4</sup>Wall Street Journal. Jannock Buys Borden Clay. Jan. 6, 1987, p. 7.

<sup>5</sup>Ceramic Bulletin. Walter Buys Brick Companies. V. 65, No. 3, 1986, p. 416.

<sup>6</sup>Kings Mountain Herald. Buyer Being Sought for Footo Mineral. July 30, 1986.

<sup>7</sup>Beaufort Hyde News. Texasgulf Fined \$5.7 Million. Jan. 8, 1987.

<sup>8</sup>Spruce Pine News Journal. IMC Purchased Again. Nov. 20, 1986.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Geologist, North Carolina Geological Survey Section, Raleigh, NC.

<sup>3</sup>U.S. Department of the Interior. North Carolina and

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, smelter: Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Stanly.
Clays: Hammill Construction Co.	Route 2, Box 33H Gold Hill, NC 28071	Open pit mines and plant.	Cabarrus and Rowan.
Pine Hall Brick & Pipe Co	Box 11044 Winston-Salem, NC 27105	do	Rockingham and Stokes.
Virginia Solite Corp	Box 27211 Richmond, VA 23261	do	Rockingham and Stanly.
Feldspar: The Feldspar Corp. <sup>1</sup>	Box 99 Spruce Pine, NC 28777	do	Mitchell.
Indusmin Inc. <sup>1</sup>	Box 309 Spruce Pine, NC 28777	do	Do.
International Minerals & Chemical Corp. <sup>1</sup> (purchased by Unimin Corp. in 1986).	23157 Sanders Rd. Northbrook, IL 60062	do	Do.
Lithium: Footo Mineral Co. <sup>2</sup>	Box 792 Kings Mountain, NC 28086	Open pit mine and plant.	Cleveland.
Lithium Corp. of America Inc. <sup>1, 2</sup>	449 North Cox Rd. Gastonia, NC 28052	do	Gaston.
Mica: Deneen Mica Co	Box 28 Micaville, NC 28755	Open pit mines	Yancey.
Harris Mining Co. <sup>3</sup> (purchased by Unimin Corp. in 1985).	Box 628 Spruce Pine, NC 28777	do	Avery.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Mica —Continued</b>			
Kings Mountain Mica Co. Inc. <sup>2</sup> (name changed to KMG Minerals Inc. in 1986).	Box 729 Kings Mountain, NC 28086	Open pit mines ----	Cleveland.
Olivine: International Minerals & Chemical Corp. (purchased by AIMCOR in 1986).	Box 672 Spruce Pine, NC 28777	Open pit mine and plant.	Jackson and Yancey.
Perlite (expanded): Carolina Perlite Co. Inc. ----	Box 741 Hillside, NJ 07205	Plant -----	Rowan.
Phosphate rock: Texasgulf Inc. <sup>4</sup> -----	Box 48 Aurora, NC 27806	Open pit mine and plant.	Beaufort.
Pyrophyllite: Glendon Pyrophyllite Inc. ----	Box 306 Carthage, NC 28327	Open pit mines and plant.	Alamance and Moore.
Piedmont Minerals Co. <sup>5</sup> ----	Box 7247 Greensboro, NC 27407	Open pit mine and plant.	Orange.
Standard Minerals Co. Inc. ---	Box 278 Robbins, NC 27325	-----do-----	Moore.
Sand and gravel (construction): Becker Sand & Gravel Co. ----	Box 698 Lillington, NC 27546	Pits -----	Anson and Harnett.
W. R. Bonsal Co. -----	Box 38 Lilesville, NC 28091	-----do-----	Anson.
B. V. Hedrick Gravel and Sand Co. <sup>1</sup> -----	Box 8 Lilesville, NC 28091	-----do-----	Buncombe.
Stone: Martin Marietta Corp. -----	Box 30013 Raleigh, NC 27622	-----do-----	Various.
Nello L. Teer Co. -----	Box 1131 Durham, NC 27702	-----do-----	Do.
Vulcan Materials Co., Mideast Div. -----	Box 7497 Winston-Salem, NC 27109	-----do-----	Do.
Talc: Warner Corp. -----	Box 672 Murphy, NC 28906	Underground mine -	Cherokee.
Vermiculite (exfoliated): W. R. Grace & Co. -----	62 Whittemore Ave. Cambridge, MA 02140	Plant -----	Guilford.

<sup>1</sup>Also mica.<sup>2</sup>Also feldspar.<sup>3</sup>Also clays.<sup>4</sup>Also byproduct gypsum.<sup>5</sup>Also sericite.



# The Mineral Industry of North Dakota

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

By Leon E. Esparza<sup>1</sup> and David W. Brekke<sup>2</sup>

The value of North Dakota's nonfuel mineral production decreased over \$3 million in 1986 from that reported for 1985. Total value in 1986 was \$20.8 million. The State ranked 48th nationally in nonfuel mineral production, accounting for less than 1% of the U.S. total. Construction sand and gravel contributed the greatest amount to the State's nonfuel mineral value and to its decline. Other commodities produced in-

cluded clays, lime, peat, salt, industrial sand, and crushed stone. Of these, only clays and lime increased in production and value for the year. Elemental sulfur was recovered from natural gas processing.

A total of 1,702 residential units were authorized in 1986, 939 permits fewer than were issued in 1985. Valuation of nonresidential construction in 1986 was \$80.6 million, a 9% decrease from that of 1985.

Table 1.—Nonfuel mineral production in North Dakota<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones-----	NA	*\$2	NA	*\$2	NA	\$2
Lime----- thousand short tons--	60	5,912	56	5,562	74	7,359
Sand and gravel (construction)----- do.---	6,426	11,351	*6,900	*13,800	5,135	10,741
Combined value of clays, peat, salt, sand and gravel (industrial, 1986), and stone (crushed miscellaneous, 1985-86)-----	XX	4,529	XX	4,820	XX	2,700
Total-----	XX	21,794	XX	24,184	XX	20,802

\*Estimated. NA Not available. XX Not applicable.

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

**Table 2.—Nonfuel minerals produced in North Dakota in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Bottineau -----	Peat.
Bowman -----	Salt.
McKenzie -----	Do.
Mercer -----	Stone (crushed).
Morton -----	Clays.
Pembina -----	Lime.
Richland -----	Do.
Traill -----	Do.
Williams -----	Salt.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Table 3.—Indicators of North Dakota business activity**

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	687	685	679
Total civilian labor force -----	do.	327	333	331
Unemployment -----	percent	5.1	5.9	6.3
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	7.5	6.9	4.7
Nonmetallic minerals except fuels <sup>1</sup> -----	do.	.4	.4	.4
Coal mining -----	do.	1.3	1.4	1.2
Oil and gas extraction -----	do.	5.8	5.1	3.1
Manufacturing total -----	do.	15.5	15.4	15.4
Stone, clay, and glass products -----	do.	.8	.8	.7
Chemicals and allied products <sup>2</sup> -----	do.	.1	.1	.1
Petroleum and coal products <sup>2</sup> -----	do.	.4	.4	.4
Construction -----	do.	13.7	11.7	10.8
Transportation and public utilities -----	do.	16.4	16.5	15.9
Wholesale and retail trade -----	do.	67.6	67.6	66.8
Finance, insurance, real estate -----	do.	12.2	12.4	12.4
Services -----	do.	57.4	57.9	59.2
Government and government enterprises -----	do.	62.2	63.1	63.7
<b>Total</b> -----	do.	252.5	251.5	248.9
<b>Personal income:<sup>3</sup></b>				
Total -----	millions	\$7,912	\$8,174	\$8,470
Per capita -----		\$11,521	\$11,934	\$12,472
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		38.4	38.6	38.2
Total average hourly earnings, production workers -----		\$7.9	\$8.1	\$8.2
<b>Earnings by industry:</b>				
Farm income -----	millions	\$637	\$707	\$799
Nonfarm -----	do.	\$4,951	\$5,046	\$5,088
Mining total -----	do.	\$225	\$218	\$152
Nonmetallic minerals except fuels -----	do.	\$11	\$10	\$4
Coal mining -----	do.	\$57	\$64	\$57
Oil and gas extraction -----	do.	\$158	\$144	\$91
Manufacturing total -----	do.	\$320	\$332	\$335
Primary metal industries -----	do.	\$1	(*)	(*)
Stone, clay, and glass products -----	do.	\$17	\$17	\$16
Chemicals and allied products -----	do.	\$3	\$3	\$3
Construction -----	do.	\$432	\$370	\$365
Transportation and public utilities -----	do.	\$538	\$539	\$534
Wholesale and retail trade -----	do.	\$1,027	\$1,053	\$1,035
Finance, insurance, real estate -----	do.	\$249	\$264	\$282
Services -----	do.	\$1,036	\$1,093	\$1,150
Government and government enterprises -----	do.	\$1,092	\$1,167	\$1,205
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>5</sup> -----		3,185	2,641	1,702
Value of nonresidential construction <sup>5</sup> -----	millions	\$97.7	\$88.1	\$80.6
Value of State road contract awards <sup>6</sup> -----	do.	\$119.6	\$137.7	\$101.1
Shipments of portland and masonry cement to and within the State <sup>7</sup> -----	thousand short tons	352	291	281

See footnotes at end of table.

Table 3.—Indicators of North Dakota business activity —Continued

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
Nonfuel mineral production value:			
Total crude mineral value ----- millions --	\$21.8	\$24.2	\$20.8
Value per capita -----	\$32	\$35	\$31

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Job Service North Dakota.

<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Less than 1/2 unit.

<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

<sup>7</sup>Has no cement-producing plants.

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

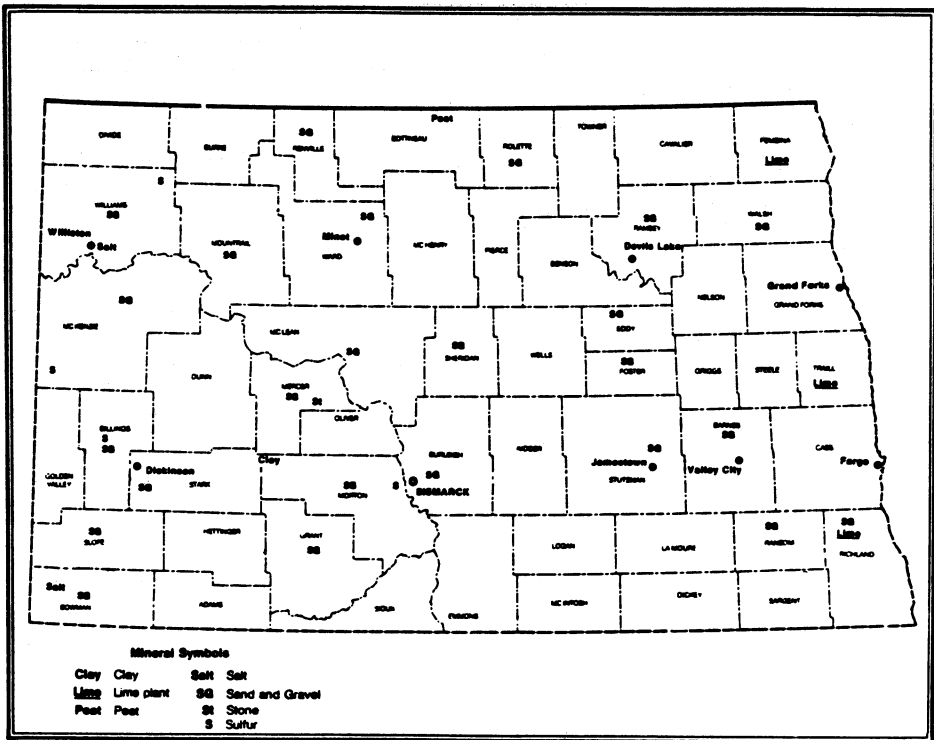


Figure 1.—Principal mineral-producing localities in North Dakota.

**Employment.**—Average annual employment in the nonfuel minerals industry for 1986 was 370, or about the same as that reported for 1985.

**Exploration Activities.**—Mineral exploration during 1986 was meager. The North

Dakota Geological Survey (NDGS) issued only six permits for coal exploration, and all were for extensions of existing mines. Two class III underground injection permits were issued to existing salt solution mines.

**Table 4.—North Dakota: Noncoal surface mining activities**

	1984	1985	1986
Number of mine operators	40	38	39
Number of active pits	153	107	123
Acres disturbed	462	370	287
Minerals mined:			
Clays	133	44	56
Rock (cobbles)	—	11	16
Sand and gravel	3,330	2,974	2,502
Scoria	104	83	85

Source: North Dakota State Soil Conservation Committee. 1984, 1985, and 1986 issues of Surface Mining Report for Minerals Other Than Coal.

**Legislation and Government Programs.**—The NDGS was the State's primary research agency concerned with mineral resources. The NDGS performed geologic studies and disseminated geologic information; regulated coal exploration, subsurface minerals, geothermal energy, and nuclear waste disposal; and maintained a core and sample library. A number of projects were under way in 1986, including surface, subsurface, and environmental studies. Work in surficial geology continued on the 1" by 1" atlas series, the two remaining county geology studies, a river evaluation in conjunction with the State Parks and Recreation Department, and paleontological studies. Subsurface work included a detailed study of the Nesson Anticline and studies of the Duperow, Inyan Kara, and Lodgepole Formations in the Williston Basin. Environmental projects included studying the geochemistry of Cretaceous shales and cooperative projects with the State Health Department on radon distribution and ground water contamination.

During 1986, NDGS issued several new publications, including maps showing depth to bedrock in the State and the Madison Group subcrop in north-central North Dakota, a report on the structure and stratigraphy of the Frobisher-Alida and Ratcliffe intervals, an update on oil exploration and development, a compilation of oil well data into a well schedule, and a revised North Dakota stratigraphic column. Despite the downturn in the petroleum industry, more than 700 geologists visited the core and

sample library and examined in excess of 48,500 feet of Williston Basin core.

The State received \$505,988 during fiscal year 1986 from the U.S. Bureau of Land Management to offset fiscal impacts caused by the presence of certain tax-exempt lands within local government boundaries. This payment was in accordance with the Payments in Lieu of Taxes Act of 1976. Also received was a Federal grant of \$328,716 to administer restoration of land and water resources adversely affected by coal mines abandoned before the 1977 Surface Control and Reclamation Act was passed.

The U.S. Bureau of Mines provided \$142,000 in fiscal year 1986 to fund the Mining and Mineral Resources Research Institute at the University of North Dakota, Grand Forks. The funds were used to encourage the training of engineers and scientists in mineral-related disciplines and to assist the institute in its operations and research. Additional sources of funds included private and industrial sponsors and government agencies. The institute did not receive direct funding from the State.

Two areas of study by the institute that were of particular interest to the nonfuel minerals industry involved developing uses for fly ash derived from coal-fired electric power generating stations. One study focused on formulating mixtures of fly ash, soil, lime, portland cement, and water, which have potential as economic liners for waste disposal sites. A second study evaluated the feasibility of using fly ash in cement and/or concrete products.

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

**Clays.**—Clay production and value increased over that reported for 1985. Hebron Brick Co., in Morton County, was the sole commercial clay producer in the State. Brick and tile were manufactured from clay deposits in the White River Formation of Oligocene age and marketed throughout Canada, the Midwest, and the Pacific Northwest. The plant, which had an annual capacity of about 20 million brick, had been in operation since 1904 and was generally in production for 10 months per year, weather permitting.

**Lime.**—Production and value of lime increased 32% in 1986 over that reported in 1985. Most of the production was used to process sugar beets, and the 1986 increase was viewed as a cyclical fluctuation. The sugar industry experienced a slightly longer than usual refining season in 1986.

**Peat.**—Peat production was reported by one company in the State. Peat Products Co., Bottineau County, in the north-central part of the State, reported a moderate decrease in production and value for 1986.

**Salt.**—Salt production and value in 1986 dropped more than 54% and 48%, respectively, compared with 1985 figures. Salt producers were adversely affected by a general downturn in the oil industry but remained in operation at reduced levels. They were expected to resume normal production levels once activity in the oil industry revived.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Production and value decreased about 26% and 22%, respectively, from the estimates given for 1985. Average value per short ton increased almost 5%. Falling interest rates failed to spur building construction in North Dakota, whose general economy is heavily dependent upon agriculture and the petroleum industry, both of which operated at depressed levels in 1986.

Table 5.—North Dakota: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	141	\$452	\$3.21
Asphaltic concrete aggregates and other bituminous mixtures -----	642	2,143	3.34
Road base and coverings <sup>1</sup> -----	1,854	2,982	1.60
Fill -----	49	160	3.27
Snow and ice control -----	10	35	3.50
Railroad ballast -----	( <sup>2</sup> )	1	4.35
Other <sup>3</sup> -----	2,438	4,968	2.04
Total or average -----	*5,135	10,741	2.09

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Less than 1/2 unit.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data do not add to total shown because of independent rounding.

**Stone (Crushed).**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates. Production and value were estimated to have increased by about 30% in 1986, compared with those of 1985.

**Sulfur (Recovered).**—Elemental sulfur sold or used in 1986 decreased by almost 5% from the figures reported for 1985. Total

value, however, increased by about 15%. Elemental sulfur was produced during natural gas processing at five plants in Billings, McKenzie, and Williams Counties in the western part of the State and at a petroleum refinery in Morton County in the southern portion of North Dakota.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>Geologist, North Dakota Geological Survey, Grand Forks, ND.



Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Clays:</b>			
Hebron Brick Co -----	Box 5 Washington Ave. East Hebron, ND 58638	Pit and plant -----	Morton.
<b>Lime:</b>			
American Crystal Sugar Co -----	Box 190 Drayton, ND 58225	Shaft kilns at beet sugar refineries.	Pembina and Traill.
Minn-Dak Farmers Co-op -----	Wahpeton, ND 58075 -----	-----do-----	Richland.
<b>Peat:</b>			
Peat Products Co -----	821 4th St. Bismarck, ND 58501	Bog -----	Bottineau.
<b>Salt:</b>			
Diamond Crystal Salt Co -----	916 South Riverside St. Clair, MI 48640	Solids evaporated from brines.	Williams.
Koch Exploration Co -----	Box 2256 Wichita, KS 67201	Brines -----	Bowman.
<b>Sand and gravel (construction):</b>			
Badinger Sand & Gravel Co -----	Box 306 Dickinson, ND 58601	Pits and plants -----	Stark.
Bradshaw Gravel Supply Inc -----	Box 1677 Grand Forks, ND 58206	-----do-----	Grand Forks, Rolette, Walsh.
Des Lacs Sand & Gravel Co -----	Box 66 Des Lacs, ND 58733	-----do-----	Various.
Fisher Sand & Gravel Co -----	Box 1034 Dickinson, ND 58601	-----do-----	Do.
Northern Improvement Co -----	Box 1254 Bismarck, ND 58501	-----do-----	Burleigh.
Schriock Construction Inc -----	3009 South Broadway Minot, ND 58701	-----do-----	Various.
<b>Stone (crushed, 1985):</b>			
Helm Bros. Inc -----	Box 787 Mandan, ND 58554	Pit -----	Mercer.
The North American Coal Corp -----	Box 299 Beulah, ND 58523	Pit -----	Do.
<b>Sulfur (recovered):</b>			
Chevron USA Inc -----	Box 1589 Tulsa, OK 74101	Plant -----	Billings.
Koch Hydrocarbon Co -----	Box 2256 Wichita, KS 67201	Plants -----	McKenzie and Williams.
Western Gas Processors Ltd -----	10701 Melody Dr. North Glenn, CO 80234	Plant -----	Billings.

# The Mineral Industry of Ohio

By L. J. Prosser, Jr.<sup>1</sup>

The value of nonfuel mineral production in Ohio in 1986 was \$610 million, the highest in State history and ranked the State 13th in the Nation. Strong demand for crushed stone and sand and gravel from the construction industry resulted in increased

prices and production of these commodities. In the metals sector, particularly in steel, productivity and efficiency were increased through restructuring and modernization programs during the past few years.

Table 1.—Nonfuel mineral production in Ohio<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons	101	\$8,092	110	\$10,412	138	\$11,540
Portland ----- do	1,525	69,810	1,769	84,929	1,706	79,383
Clays ----- do	1,960	10,473	2,114	10,581	2,833	11,515
Gem stones ----- do	NA	W	NA	<sup>e</sup> 10	NA	10
Lime ----- thousand short tons	1,859	87,951	1,730	84,142	1,648	81,103
Peat ----- do	13	345	16	413	6	W
Salt ----- do	W	W	<sup>r</sup> 4,329	<sup>r</sup> 180,964	4,115	126,757
Sand and gravel:						
Construction ----- do	31,748	104,709	<sup>e</sup> 33,000	<sup>e</sup> 109,000	36,806	126,747
Industrial ----- do	1,506	20,829	1,312	21,945	1,221	21,183
Stone:						
Crushed ----- do	<sup>e</sup> 38,500	<sup>e</sup> 139,000	38,310	136,544	<sup>e</sup> 39,300	<sup>e</sup> 147,300
Dimension ----- do	<sup>r</sup> <sup>e</sup> 55	<sup>r</sup> <sup>e</sup> 2,364	53	3,661	<sup>e</sup> 36	<sup>e</sup> 2,708
Combined value of abrasives, gypsum, and values indicated by symbol W	XX	108,240	XX	1,541	XX	1,738
Total -----	XX	<sup>r</sup> 551,813	XX	<sup>r</sup> 594,142	XX	609,984

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Ohio in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adams	Stone (crushed).
Allen	Do.
Ashland	Peat.
Ashtabula	Lime.
Athens	Stone (crushed).
Auglaize	Stone (crushed), clays.
Belmont	Stone (crushed).
Brown	Do.
Carroll	Do.
Champaign	Peat.
Clark	Stone (crushed).
Clinton	Do.
Columbiana	Clays.
Coshocton	Stone (dimension), clays.
Crawford	Stone (crushed).
Cuyahoga	Salt, clays, peat.
Darke	Stone (crushed).
Delaware	Do.
Erie	Stone (crushed), lime, sand (industrial).
Fayette	Stone (crushed).
Franklin	Do.
Gallia	Sand (industrial).
Geauga	Sand (industrial), stone (crushed).
Greene	Cement, stone (crushed), clays.
Hancock	Stone (crushed).
Hardin	Do.
Harrison	Clays.
Highland	Stone (crushed).
Hocking	Clays.
Holmes	Clays, stone (dimension).
Huron	Stone (crushed).
Jackson	Clays, stone (crushed).
Knox	Sand (industrial), stone (dimension).
Lake	Salt, lime.
Lawrence	Cement, stone (crushed), clays.
Licking	Clays.
Logan	Stone (crushed), peat.
Lorain	Stone (dimension), stone (crushed), abrasives.
Lucas	Stone (crushed), cement, clays.
Mahoning	Stone (crushed), clays.
Marion	Do.
Medina	Clays.
Mercen	Stone (crushed).
Miami	Do.
Monroe	Do.
Montgomery	Do.
Morgan	Do.
Muskingum	Cement, stone (crushed), clays.
Noble	Stone (crushed).
Ottawa	Stone (crushed), lime, gypsum.
Paulding	Cement, stone (crushed), clays.
Perry	Sand (industrial), stone (crushed), clays.
Pike	Stone (crushed).
Preble	Do.
Putnam	Stone (crushed), clays.
Ross	Sand (industrial).
Sandusky	Lime, stone (crushed).
Scioto	Stone (dimension).
Seneca	Stone (crushed), stone (dimension).
Shelby	Stone (crushed).
Stark	Cement, stone (crushed), clays.
Summit	Salt.
Trumbull	Stone (crushed).
Tuscarawas	Clays, stone (crushed), sand (industrial).
Union	Stone (crushed).
Van Wert	Do.
Wayne	Salt, stone (crushed).
Williams	Peat.
Wood	Stone (crushed).
Wyandot	Stone (crushed), peat, clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

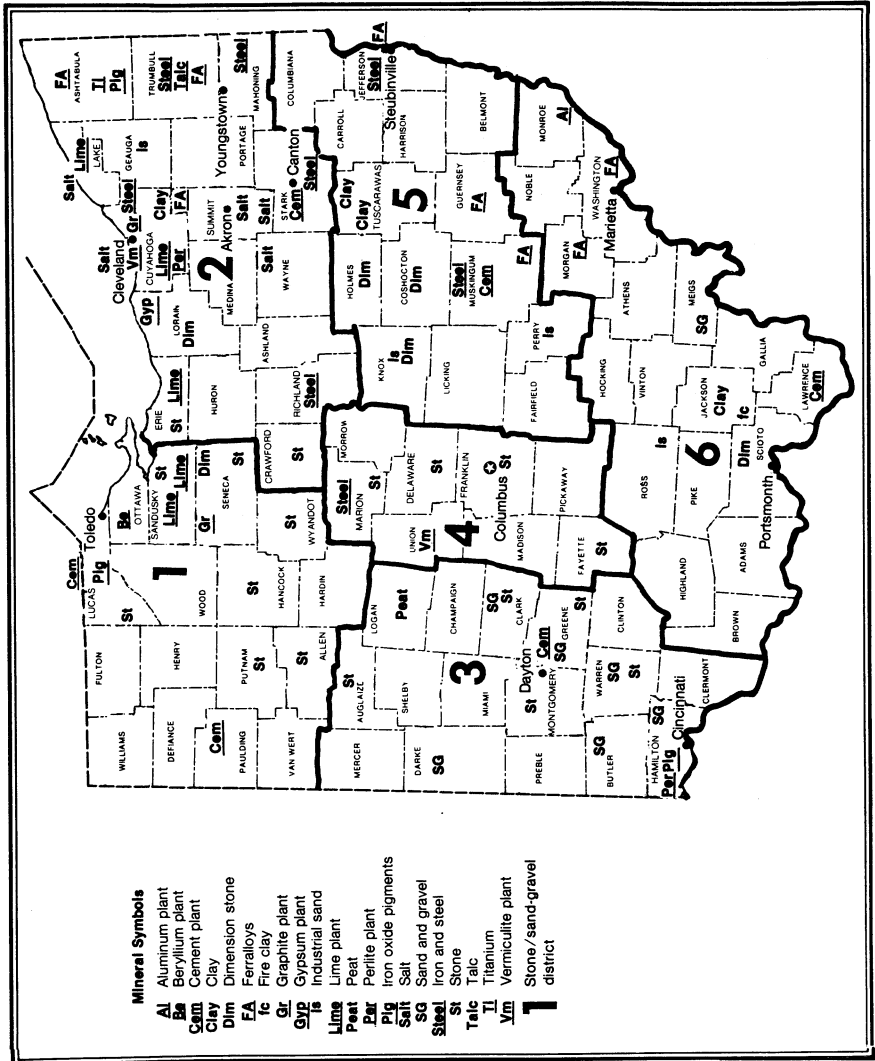
<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Ohio business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population .....	10,744	10,747	10,752
Total civilian labor force .....	5,089	5,139	5,234
Unemployment .....	9.4	8.9	8.1
<b>Employment (nonagricultural):</b>			
Mining total .....	27.8	26.1	22.7
Coal mining .....	11.7	10.8	10.1
Oil and gas extraction .....	11.7	10.8	8.0
Manufacturing total .....	1,127.0	1,124.2	1,109.3
Primary metal industries .....	108.9	101.8	95.4
Stone, clay, and glass products .....	52.5	50.5	49.4
Chemicals and allied products .....	62.7	62.8	63.1
Petroleum and coal products <sup>1</sup> .....	8.9	9.3	8.8
Construction .....	144.8	154.1	160.8
Transportation and public utilities .....	203.9	202.7	205.5
Wholesale and retail trade .....	984.7	1,031.7	1,066.5
Finance, insurance, real estate .....	211.5	219.3	231.8
Services .....	905.2	949.5	998.8
Government and government enterprises .....	655.2	665.2	679.8
Total <sup>2</sup> .....	4,260.2	4,372.9	4,475.2
<b>Personal income:</b>			
Total .....	\$135,040	\$142,685	\$149,807
Per capita .....	\$12,569	\$13,376	\$13,933
<b>Hours and earnings:</b>			
Total average weekly hours, production workers .....	42.3	42.0	42.1
Mining .....	43.9	43.7	43.6
Total average hourly earnings, production workers .....	\$11.0	\$11.4	\$11.6
Mining .....	\$11.3	\$11.6	\$12.0
<b>Earnings by industry:<sup>3</sup></b>			
Farm income .....	\$1,002	\$976	\$889
Nonfarm .....	\$97,004	\$103,151	\$108,347
Mining total .....	\$1,139	\$1,178	\$1,082
Nonmetallic minerals except fuels .....	\$112	\$114	\$97
Coal mining .....	\$520	\$494	\$477
Oil and gas extraction .....	\$508	\$567	\$499
Manufacturing total .....	\$33,424	\$34,911	\$35,413
Primary metal industries .....	\$3,991	\$3,858	\$3,659
Stone, clay, and glass products .....	\$1,485	\$1,529	\$1,542
Chemicals and allied products .....	\$2,085	\$2,186	\$2,302
Petroleum and coal products .....	\$431	\$471	\$462
Construction .....	\$4,822	\$5,074	\$5,372
Transportation and public utilities .....	\$4,437	\$6,482	\$6,735
Wholesale and retail trade .....	\$15,137	\$16,260	\$17,136
Finance, insurance, real estate .....	\$4,400	\$4,764	\$5,607
Services .....	\$18,869	\$20,914	\$22,718
Government and government enterprises .....	\$12,459	\$13,258	\$13,935
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> .....	30,072	33,024	44,460
Value of nonresidential construction <sup>4</sup> .....	\$2,135.8	\$2,139.6	\$2,443.6
Value of State road contract awards <sup>5</sup> .....	\$590.3	\$685.3	\$931.0
Shipments of portland and masonry cement to and within the State .....	2,736	2,781	3,202
<b>Nonfuel mineral production value:</b>			
Total crude mineral value .....	\$551.8	\$594.1	\$610.0
Value per capita .....	\$51	\$55	\$57

<sup>P</sup>Preliminary. <sup>T</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—Ohio remained more dependent on the mining and mineral-consuming sectors of its economy for employment. Mining, construction, and manufacturing accounted for 29% of Ohio's nonagricultural employment.<sup>2</sup> Nationally, these industries provided about 25% of the employment.

Also, the unemployment rate has declined each year since 1979, when Ohio's value of nonfuel mineral production increased. A significant change occurred in 1984 when the mineral value increased \$73 million over that of 1983 and the unemployment rate dropped by nearly 3%. In 1986, mineral value increased \$16 million over that of 1985 and the unemployment rate decreased from 8.9% to 8.1%.

**Legislation and Government Programs.**—The Ohio Division of Geological Survey (DGS) was the primary State agency involved in mineral resource investigations. The 1986 "DGS Report on Ohio Mineral Industries" included a directory of 309 coal and 462 industrial minerals operators that reported production, an increase of 10 and 17 operators, respectively, compared with

that of 1985.<sup>3</sup>

The DGS core-drilling program completed 20 coreholes with a total footage of 8,131 feet. Geologic data generated from the drilling were used in stratigraphic studies and coal exploration and correlation work.

The Ohio Department of Transportation, Akron University, and the Ohio Aggregates Association planned a study on utilization of below-standard or below-specification construction aggregate material. The study, to begin in 1987, will include a survey of aggregate producers and consumers to determine the amount of aggregate waste available. Laboratory testing was also planned to characterize physical properties of selected samples.

Ohio State University's Mining and Mineral Resources and Research Institute received a \$142,000 grant from the U.S. Bureau of Mines under the second year of Public Law 98-409. Ohio State University was also an affiliate of the University of Missouri at Rolla, one of the five generic mineral technology centers in the United States with expertise in the area of pyrometallurgy.

**REVIEW BY NONFUEL MINERAL COMMODITIES**

**INDUSTRIAL MINERALS**

The nonfuel mineral commodities identified in table 1 are discussed in this section. Processed or manufactured commodities included graphite (manufactured), iron and steel slag, sulfur (recovered), and vermiculite (exfoliated); the combined value of these commodities was about \$36 million.

**Abrasives (Natural).**—Cleveland Quarries Co. was the Nation's only producer of natural grindstones. The special silica stone product was selectively mined as a coproduct of the company's dimension sandstone quarry in South Amherst, Lorain County.

**Cement.**—The value of Ohio's cement shipments accounted for 15% of the State's nonfuel mineral value. The cement industry in Ohio produced about 2% of the Nation's portland cement and 4% of the masonry cement.

**Table 4.—Ohio: Masonry cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	4	4
Production	113,369	129,975
Shipments from mills:		
Quantity	110,329	137,919
Value	\$10,411,783	\$11,540,278
Stocks at mills, Dec. 31	26,302	18,358

**Table 5.—Ohio: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	6	6
Production	1,737,689	1,656,900
Shipments from mills:		
Quantity	1,769,119	1,706,160
Value	\$84,928,636	\$79,382,509
Stocks at mills, Dec. 31	213,287	163,296

**Clays.**—Conditions in Ohio's clay industry continued to improve for common clay producers and to decline for fire clay operators. Common clay production increased 42% to 2.7 million short tons, the highest level since 1979. Output in 1986 was attributed to strong demand from the construction industry, particularly in home building. The number of housing units in 1986 was 35% above the 1985 total. The State ranked first nationally in output of common clay, accounting for 9% of the U.S. output.

Although Ohio ranked second in the United States in fire clay output, with 30% of the national total, production declined by 28%. Nationally, fire clay output dropped by about 40%, to the lowest total reported in 10 years. Declining demand from the

steel industry because of production cut-backs adversely affected the fire clay industry both nationally and in Ohio.

**Gypsum.**—Ohio was 1 of 20 States that mined crude gypsum, although ranking among the bottom 5 producing States. One company mined gypsum in Ottawa County for wallboard manufacture. Two other companies manufactured wallboard but obtained gypsum from out-of-State sources.

**Lime.**—Output decreased slightly in 1986, but Ohio remained the Nation's leading lime-producing State. About 11% of the U.S. lime output came from nine operations in Ohio. Since 1979, lime production in Ohio has declined by about 50%, following a similar trend in the major consuming industry of lime—steel.

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

Use	1985		1986	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace -----	869,438	\$47,450	908,932	\$24,265
Sewage treatment -----	43,194	2,304	W	W
Other <sup>1</sup> -----	817,077	34,388	739,560	56,838
Total -----	1,729,709	84,142	1,648,492	81,103

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

<sup>1</sup>Includes acid water neutralization; agriculture; calcium carbide; finishing lime; glass; ladle desulfurization (1986); mason's lime (1986); magnesium; other chemical and industrial uses; paper and pulp; refractories; road stabilization; steel, electric and open-hearth; sugar refining; water purification; and data indicated by symbol W.

**Peat.**—Output declined sharply because the State's leading producer, Weaver's Lawn & Garden Products Inc., closed. The closing was attributed to a change in ownership, with speculation the land will be used for a different purpose. In 1986, four companies reported production.

**Salt.**—The State's salt industry remained stable because demand for salt was less dependent on economic conditions in other industries or in the State. Ohio's salt production was mostly consumed to melt snow and ice and, to a lesser extent, by the food-related industries. Ohio ranked fourth in the Nation in salt production, accounting for about 11% of the U.S. total.

**Sand and Gravel.**—**Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Output in 1986 of 36.8 million short tons was the highest total reported in 7 years. Since 1979, production has followed the trend in demand by the construction indus-

try. During the period of high interest rates in 1982 and 1983, sand and gravel output dropped to an average of about 27 million tons per year. As economic conditions improved for the building industry, beginning in 1984, production of construction sand and gravel surpassed 30 million tons and continued to increase through 1986. Nationally, Ohio ranked fifth in output.

**Industrial.**—The third consecutive year of declining industrial sand production reflected the shrinking market for sand used in glass manufacture and foundry applications. In 1986, 6 companies mined industrial sand at 11 pits.

The Ohio Supreme Court was expected to decide in 1987 if Best Silica Sand Co. can continue producing industrial sand at its site in Bainbridge, Geauga County. The court agreed to accept Bainbridge Township's appeal of an 11th District Court of Appeals ruling that allowed Best Silica to continue mining. The decision also has the potential to set a precedent on which body of government, State or local, has final jurisdiction on zoning disputes that involve mining. The deposit has an estimated 8 million short tons of reserves.

**Table 7.—Ohio: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	7,524	\$24,767	\$3.29
Plaster and gunita sands -----	434	1,502	3.46
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	457	2,011	4.40
Asphaltic concrete aggregates and other bituminous mixtures -----	4,347	15,054	3.46
Road base and coverings <sup>1</sup> -----	5,131	18,184	3.55
Fill -----	3,925	9,333	2.38
Snow and ice control -----	161	565	3.51
Railroad ballast -----	41	140	3.41
Other -----	1,011	3,546	3.51
Other unspecified <sup>2</sup> -----	13,773	51,646	3.75
Total <sup>3</sup> or average -----	36,806	126,747	3.44

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

**Table 8.—Ohio: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	500	1,952	3,332	10,710	1,530	5,148
Asphaltic concrete aggregates and other bituminous mixtures -----	151	W	1,116	4,541	885	2,404
Road base and coverings <sup>2</sup> -----	247	485	741	2,930	3,477	12,282
Fill -----	66	142	1,041	3,334	2,406	4,855
Other unspecified <sup>3</sup> -----	337	1,071	2,800	11,901	7,737	28,624
Total <sup>4</sup> -----	1,299	3,650	9,030	33,416	16,035	53,313
Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	1,001	3,690	1,114	3,837	939	2,943
Asphaltic concrete aggregates and other bituminous mixtures -----	601	2,254	1,047	3,313	548	W
Road base and coverings <sup>2</sup> -----	157	566	360	1,275	149	645
Fill -----	147	444	230	496	36	63
Other unspecified <sup>3</sup> -----	2,036	8,126	1,580	4,968	498	3,749
Total <sup>4</sup> -----	3,941	15,079	4,331	13,890	2,170	7,399

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

<sup>1</sup>Includes plaster and gunita sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes snow and ice control, railroad ballast, other specified uses, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Ohio produced 4% of the Nation's crushed stone and ranked 11th. Output in 1986 of 39.3 million short tons was the highest since 1980. In line with increased demand from the construction industry, production averaged 38.7 million tons per

year from 1984 through 1986, about 7 million tons per year more than the average for the 3 previous years. Improved production was expected to continue because of a 2-year, \$1.9 billion highway construction program initiated by the State in January.

Demand from the construction industry has benefited crushed stone producers. However, sales to lime and steel manufacturers have declined. As these markets eroded, technological developments using limestone to clean or scrub high-sulfur coal



have expanded. About 90% of the stone mined in the State was limestone. In 1985, Ohio voters approved a referendum providing \$100 million for "clean coal" research, and in 1986, the Ohio Coal Development Office awarded \$41.6 million of the \$100 million for 24 demonstration and research projects. Projects designed to use limestone included American Electric Power Co.'s planned powerplant in Brilliant utilizing a combination of pressurized- and fluidized-bed technologies. In this process, limestone is mixed with coal to absorb sulfur during combustion. PEDCO Inc. began using limestone in a demonstration project at Hudepohl Brewing Co.'s plant in Cincinnati. In this project, about 1.5 tons per day of limestone was used in a boiler with a nominal capacity of 5,000 pounds per hour and the same rate of steam production.

Ohio's leading crushed stone producer, National Lime & Stone Co., opened a new plant near Lima. The plant cost \$5 million, and limestone from a nearby company quarry was used to produce bituminous concrete, railroad ballast, and other products used by the construction industry.

Also, during the year, Maumee Stone Co., the State's fifth leading producer, began operating as Stoneco Inc. The name change occurred because of a merger. Stoneco Inc. is a subsidiary of the S. E. Johnson Co. Inc. Another of the State's top producers, The France Stone Co., was sold to Koppers Co. Inc. of Pittsburgh, PA.

*Dimension.*—Most of the State's production was dimension sandstone used for sawed and cut stone, rough irregular-shaped stone, and flagging. A small amount of dimension limestone was also quarried.

## METALS

In this section, processed and manufactured metals are discussed. No metals are mined in Ohio.

*Aluminum.*—Ohio, with one primary aluminum producer, dropped from fifth to eighth nationally in output because of a labor strike. Production was reduced by one-third to one-half of capacity during the 4-month strike that began in July.

Ownership of the operation also changed as Ohio River Associates Inc. purchased Ormet Corp.'s six-potline, 270,000-short-ton-per-year-capacity aluminum smelter and rolling mill in Hannibal. The operation employed about 2,000 workers and was important to Monroe County's economy, contributing an estimated \$700,000 per day

to the Ohio Valley area.

*Iron and Steel.*—Ohio ranked second of 11 States in pig iron shipments. Both shipments and value increased slightly to about 9.5 million short tons and \$2 billion, respectively. Steel production increased slightly to about 14.5 million tons, placing Ohio second to Indiana in total output. Of the Nation's top six steelmakers, which accounted for about 93% of U.S. steel shipments in 1986, three had operations in Ohio.

The largest steel producer in Ohio was LTV Steel Corp., with facilities in Canton, Cleveland, and Warren. In July, LTV filed for protection under chapter 11 of the Federal Bankruptcy Code. The firm cut steel-making capacity from 18.3 to 12.6 million tons and, in an effort to prioritize capital expenditures, identified its facilities as "primary," "supplementary," or "nonoperating."<sup>4</sup> Both the Canton and Cleveland works were listed as primary facilities and the Warren works as supplementary.

USX Corp., formerly United States Steel Corp., shut down most of its Lorain works prior to a nationwide work stoppage that began on July 31 and continued through yearend. The status of that operation was expected to be determined when work resumed.

Armco Inc. operated its largest steelmaking facility at Middletown, where a new \$50 million electrogalvanizing line with capacity to process 200,000 to 400,000 tons of steel per year came on-stream. Electrogalvanized steel was sold to the automotive industry.

Another electrogalvanizing operation in Walbridge began production in May. The 400,000-ton-per-year facility was a joint venture among Bethlehem Steel Corp., Inland Steel Co., Inland Steel Industries Inc., and Pre Finish Metals Inc.

*Ferroalloys.*—Ohio remained the Nation's leading producer of ferroalloys, although output dropped sharply again in 1986. Weak demand and import competition resulted in two companies announcing plans to sell their ferroalloy operations: Globe Metallurgical Inc.'s Beverly facility and Foote Mineral Co.'s Cambridge plant.

Elkem Metals Co. announced plans to manufacture chromium-aluminum briquets. The company invested \$3 million in its Marietta plant to add the briquets to its product line. Stratcor Minerals Corp.'s purchase of Umetco Minerals Corp., Union Carbide Corp.'s U.S. operations, included a ferroalloy plant also in Marietta. Ohio

Ferro-Alloys Corp., based in Canton, filed for reorganization under chapter 11 of the Federal Bankruptcy Code. Previously, Ohio Ferro-Alloys had closed both of its Ohio operations.

**Titanium.**—The TIMET Div. of Titanium Metals Corp. of America and RMI Co., the Nation's two leading integrated producers

of titanium, produced titanium mill products at their Ohio facilities.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Ohio Bureau of Employment Services. Labor Market Review. 1986 Annu. Sum., p. 4.

<sup>3</sup>Weisgarber, S. L. 1986 Report on Ohio Mineral Industries. Dep. Nat. Res. Div. Geol. Surv., 115 pp.

<sup>4</sup>LTV Steel Corp. 10-K Rep. Pp. 24-25.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Abrasives (natural):</b>			
Cleveland Quarries Co. <sup>1</sup> -----	Quarry Rd. Amherst, OH 44001	Quarry and plant	Lorain.
<b>Cement:</b>			
General Portland Inc. <sup>2</sup> -----	Box 1019 Fort Wayne, IN 46801	Plant -----	Paulding.
SME Cement Inc -----	Box 1187 Uniontown, PA 15401	Plants -----	Lucas, Muskin- gum, Stark.
Southwestern Portland Cement Co. <sup>3</sup> -----	Box 191 Fairborn, OH 45324	Plant -----	Greene.
<b>Clays:</b>			
<b>Common:</b>			
Belden Brick Co -----	Box 910 Canton, OH 44701	Pits -----	Tuscarawas.
Hydraulic Press Brick Co. -----	Box 7786 Independence, OH 44131	Pit -----	Cuyahoga.
<b>Fire:</b>			
Crescent Brick Co. Inc -----	50 Portsmouth Rd., Box 368 Oak Hill, OH 45656	Pits -----	Jackson.
<b>Gypsum:</b>			
<b>Crude:</b>			
Celotex Corp. <sup>3</sup> -----	320 South Wayne Ave. Cincinnati, OH 45215	Pit and plant ---	Ottawa.
<b>Calcined:</b>			
National Gypsum Co -----	1901 Henderson Dr. Lorain, OH 44052	Plant -----	Lorain.
USG Corp -----	Gypsum, OH 43433 -----	---do -----	Ottawa.
<b>Lime:</b>			
Huron Lime Co -----	Box 451, 100 Meeker Huron, OH 44839	Quarry and plant	Erie.
Martin Marietta Corp -----	755 Lime Rd. Woodsville, OH 43469	---do -----	Sandusky.
Ohio Lime Co -----	128 East Main St. Woodsville, OH 43469	Quarries and plants.	Do.
LTV Steel Corp -----	Box 6778, Room 1629 Republic Bldg. Cleveland, OH 44101	Plant -----	Lake.
<b>Peat:</b>			
Sphagnum Moss Peat Farm -----	9797 Thompson Rd., Route 1 West Liberty, OH 43357	Bog -----	Champaign.
<b>Salt:</b>			
Diamond Crystal Salt Co. -----	Box 149 2065 Manchester Rd. Akron, OH 44309	Well and plant --	Summit.
International Salt Co -----	2400 Ships Channel Cleveland, OH 44101	Underground mine and plant.	Cuyahoga.
Morton Thiokol Inc., Morton Salt Div	Box 390 Painesville, OH 44077	Underground mine, wells, plant.	Lake and Wayne.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
American Aggregates Corp ---	Drawer 160, Garst Ave. Greenville, OH 45331	Pits and plants (13 operations).	Butler, Cham- paign, Clark, Franklin, Greene, Hamil- ton, Montgom- ery, Warren.
Dravo Corp -----	5253 Wooster Rd. Cincinnati, OH 45226	Pits and plants (8 operations).	Butler, Hamilton, Meigs, Warren.
<b>Industrial:</b>			
Best Silica Sand Co -----	Box 87, 11830 Ravenna Rd. Chardon, OH 44024	Quarries and mill	Geauga.
Central Silica Co -----	806 Market St. Zanesville, OH 43701	---do -----	Knox and Perry.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Stone:</b>			
<b>Crushed:</b>			
American Aggregates Corp ----	Drawer 160, Garst Ave. Greenville, OH 45331	Quarries and plants.	Clark, Darke, Del- aware, Fayette, Franklin, Greene, Mont- gomery, War- ren.
The France Stone Co. <sup>1</sup> -----	Box 1928, 1800 Toledo Trust Toledo, OH 43603	Quarries and plant	Lucas, Seneca, Wood.
Martin Marietta Refractories ---	755 Lime Rd. Woodville, OH 43469	Quarry and plant	Sandusky.
National Lime & Stone Co -----	First National Bank Bldg. Findlay, OH 45840	Quarries and plants.	Allen, Auglaize, Crawford, Dela- ware, Hancock, Marion, Put- nam, Wyandot.
Sandusky Crushed Stone Co. Inc	Box 527 Sandusky, OH 44870	Quarry and plant	Erie.
Stoneco Inc -----	221 Allen St. Maumee, OH 43537	Quarries and plant	Lucas, Ottawa, Paulding, Van Wert, Wood.
Wagner Quarries Co.-----	4203 Milan Rd. Sandusky, OH 44870	---do---	Do.
<b>Dimension:</b>			
Briar Hill Stone Co -----	Box 148, State Route 520 Glenmont, OH 44628	---do---	Coshocton, Holmes, Knox.
Waller Bros. Stone Quarry Co ---	134 County Rd. McDermont, OH 45652	---do---	Scioto.

<sup>1</sup>Also dimension stone.<sup>2</sup>Also common clays.<sup>3</sup>Also calcined gypsum.

# The Mineral Industry of Oklahoma

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

By Jane P. Ohl<sup>1</sup> and Robert H. Arndt<sup>2</sup>

Nonfuel mineral production in Oklahoma was valued at \$247 million, a slight decrease from the production value of 1985, a record-high year. Nationally, the State ranked 31st in the value of nonfuel mineral output.

Construction materials represented most of the output value, with crushed stone, construction and industrial sand and gravel, crude and calcined gypsum, and portland

cement the leading commodities. The greatest increases in output were reported for salt, followed by dimension stone, pumice, industrial sand, and masonry cement; the greatest decrease was reported for construction sand and gravel.

One or more nonfuel mineral commodities were produced in 52 of Oklahoma's 77 counties.

Table 1.—Nonfuel mineral production in Oklahoma<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons..	49	\$3,506	43	\$2,854	50	\$3,198
Portland ----- do. ....	1,732	84,701	1,589	72,583	1,579	69,075
Clays ----- do. ....	979	2,498	997	2,338	993	2,329
Gem stones ----- do. ....	NA	<sup>e</sup> 2	NA	<sup>e</sup> 2	NA	2
Gypsum ----- thousand short tons..	1,549	13,485	1,595	12,548	1,683	9,855
Sand and gravel:						
Construction ----- do. ....	10,984	26,582	<sup>e</sup> 12,600	<sup>e</sup> 32,300	10,366	24,585
Industrial ----- do. ....	W	W	W	W	1,203	16,454
Stone:						
Crushed ----- do. ....	<sup>e</sup> 25,500	<sup>e</sup> 86,000	31,173	98,811	<sup>e</sup> 30,900	<sup>e</sup> 102,100
Dimension ----- do. ....	<sup>r</sup> <sup>e</sup> 9	<sup>r</sup> <sup>e</sup> 584	11	836	<sup>e</sup> 19	<sup>e</sup> 913
Combined value of feldspar, iodine, lime, pumice, salt, tripoli, and values indicated by symbol W -----	XX	28,187	XX	29,335	XX	18,504
Total -----	XX	<sup>r</sup> 245,545	XX	251,607	XX	247,015

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Oklahoma in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Atoka	Stone (crushed).
Beaver	Pumice.
Blaine	Gypsum.
Bryan	Stone (crushed).
Caddo	Stone (crushed), gypsum.
Canadian	Clays.
Carter	Stone (crushed).
Cherokee	Do.
Choctaw	Do.
Comanche	Stone (crushed), gypsum.
Craig	Stone (crushed).
Creek	Stone (crushed), clays.
Custer	Clays.
Greer	Stone (dimension), clays.
Harmon	Salt.
Haskell	Stone (crushed), stone (dimension).
Jackson	Gypsum.
Johnston	Sand (industrial), stone (crushed), stone (dimension).
Kay	Stone (crushed).
Kingfisher	Iodine.
Kiowa	Stone (crushed), stone (dimension).
Le Flore	Stone (dimension).
McCurain	Stone (crushed).
McIntosh	Do.
Major	Stone (crushed), gypsum.
Marshall	Stone (crushed).
Mayes	Cement, stone (crushed), clays.
Murray	Stone (crushed).
Muskogee	Sand (industrial), feldspar, clays.
Noble	Stone (crushed).
Nowata	Do.
Oklahoma	Clays.
Okmulgee	Stone (crushed).
Osage	Do.
Ottawa	Stone (crushed), abrasives.
Pawnee	Stone (crushed).
Payne	Do.
Pittsburg	Stone (crushed), stone (dimension).
Pontotoc	Cement, stone (crushed), clays.
Rogers	Do.
Seminole	Lime, stone (crushed), clays.
Sequoyah	Stone (crushed).
Tulsa	Do.
Wagoner	Do.
Washington	Stone (crushed), clays.
Woodward	Iodine.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Oklahoma business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	3,312	3,306	3,305
Total civilian labor force -----	do	1,556	1,562	1,593
Unemployment -----	percent	7.0	7.1	8.2
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	72.0	65.4	55.1
Oil and gas extraction -----	do	69.0	62.5	52.5
Manufacturing total -----	do	175.0	172.0	162.8
Primary metal industries -----	do	4.3	4.3	4.0
Stone, clay, and glass products -----	do	11.1	11.0	10.6
Chemicals and allied products <sup>1</sup> -----	do	3.3	3.1	2.9
Petroleum and coal products -----	do	8.8	7.9	7.3
Construction -----	do	52.3	45.1	40.0
Transportation and public utilities -----	do	66.4	64.6	64.1
Wholesale and retail trade -----	do	287.9	286.5	279.0
Finance, insurance, real estate -----	do	64.2	63.2	62.8
Services -----	do	221.2	222.6	224.5
Government and government enterprises -----	do	241.4	245.7	251.2
Total <sup>2</sup> -----	do	1,180.3	1,165.3	1,139.6
<b>Personal income:</b>				
Total -----	millions	\$38,838	\$40,243	\$40,595
Per capita -----		\$11,725	\$12,173	\$12,283
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		41.6	41.3	41.3
Total average hourly earnings, production workers -----		\$9.6	\$9.9	\$9.8
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$628	\$633	\$869
Nonfarm -----	do	\$27,385	\$28,013	\$27,592
Mining total -----	do	\$2,506	\$2,402	\$1,946
Nonmetallic minerals -----	do	\$44	\$44	\$15
Oil and gas extraction -----	do	\$2,405	\$2,311	\$1,887
Manufacturing total -----	do	\$4,590	\$4,634	\$4,440
Primary metal industries -----	do	\$123	\$121	\$121
Stone, clay, and glass products -----	do	\$281	\$296	\$296
Chemicals and allied products -----	do	\$100	\$97	\$92
Petroleum and coal products -----	do	\$386	\$342	\$333
Construction -----	do	\$1,868	\$1,766	\$1,692
Transportation and public utilities -----	do	\$2,125	\$2,138	\$2,206
Wholesale and retail trade -----	do	\$4,657	\$4,701	\$4,528
Finance, insurance, real estate -----	do	\$1,474	\$1,511	\$1,573
Services -----	do	\$4,959	\$5,346	\$5,518
Government and government enterprises -----	do	\$5,092	\$5,414	\$5,583
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		22,926	10,670	8,984
Value of nonresidential construction <sup>4</sup> -----	millions	\$799.2	\$986.2	\$419.2
Value of State road contract awards <sup>5</sup> -----	do	\$203.6	\$208.6	\$328.4
Shipments of portland and masonry cement to and within the State -----	thousand short tons	1,811	1,369	1,141
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$245.6	\$251.6	\$247.0
Value per capita -----		\$74	\$76	\$75

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

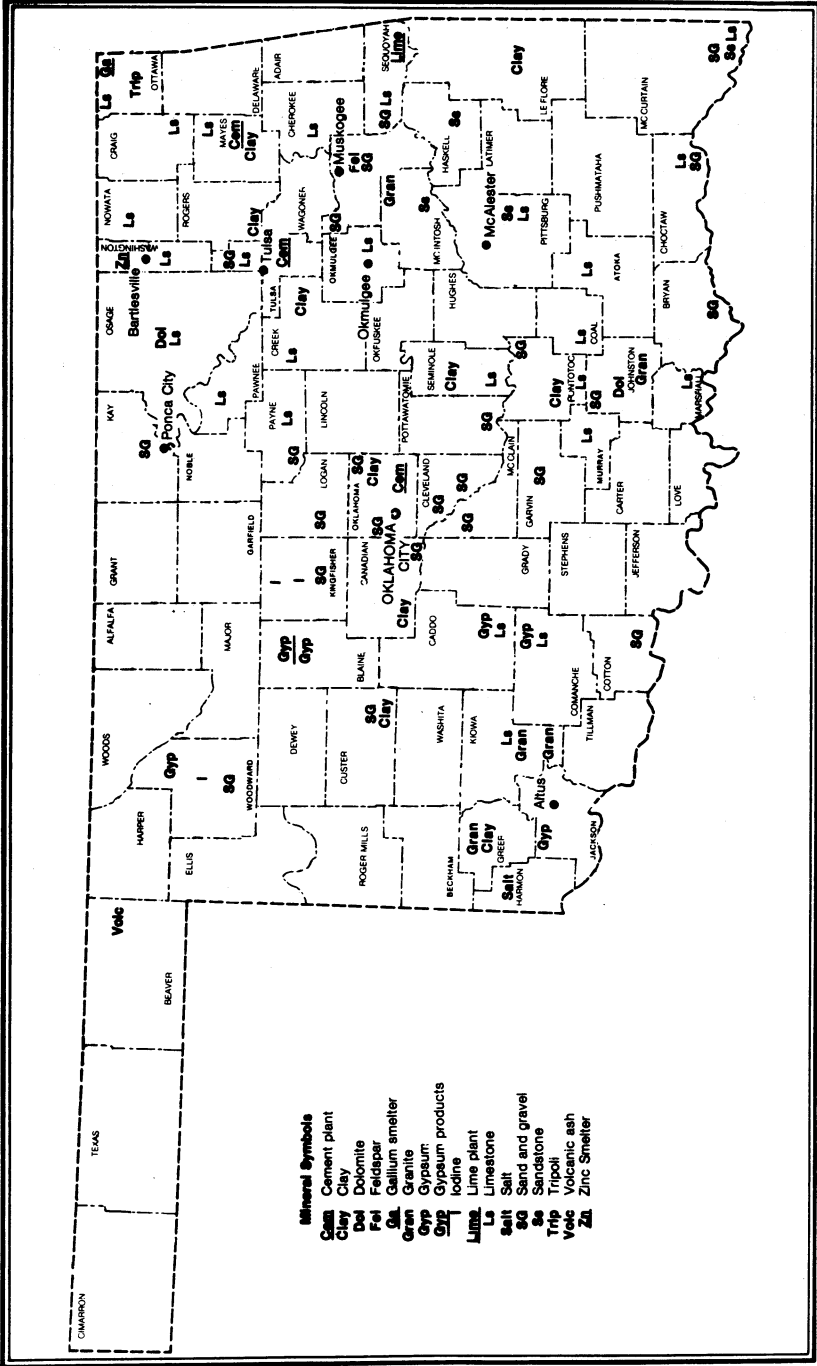


Figure 1.—Principal mineral-producing localities in Oklahoma.

**Trends and Developments.**—The State's business conditions continued at very low levels, similar to those of 1985, mainly influenced by the drastic downturn in the oil industry. The building and highway construction industries, major consumers of nonfuel minerals, continued to follow the downward trend of activity that began in 1983. Dollar volume of construction declined for the third successive year to less than \$900 million, a loss of nearly 21% from that of 1985 and the lowest total since 1970.<sup>3</sup>

Trends in mineral output and value were mainly mixed during the 1984-86 period. No distinct 3-year trends were noted for masonry cement or construction sand and gravel. For three commodities, however, distinct trends could be seen: Quantities, total values, and unit prices of feldspar and pumice trended upward, while quantity, total value, and unit price of portland cement trended downward. Unit price increases also were reported for iodine, lime, and industrial sand, in the 1984-86 period.

**Environment.**—Cleanup activities continued at the 40-square-mile Superfund site near Picher, Ottawa County. The area had been declared to be hazardous and eligible for assistance in 1981 under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Acidic waters from abandoned lead-zinc mines of the Tri-State mining district were being discharged into the Tar Creek drainage system, threatening to contaminate surface and subsurface water supplies. The first step of the \$3.7 million cleanup program, completed in 1985, consisted of clearing and plugging almost 50 abandoned wells through which contaminated acidic mine water could migrate downward toward the Roubidoux aquifer. In mid-1986, the clearing and plugging of 17 additional wells began, and the project was nearly complete by yearend. The second part of the program, the construction of diversion structures to decrease surface water inflow into the mines, began in early 1986 and was mostly

completed by the third quarter. The structures will be monitored for 2 years, during which time alternative water supplies will be planned and a decision made on whether to construct a water treatment plant.

On September 20, the Nuclear Regulatory Commission granted authorization for Sequoyah Fuels Corp. (a subsidiary of Kerr-McGee Corp.) to resume processing refined uranium into uranium hexafluoride at Sequoyah's Gore plant. The plant had been closed following a fatal accident resulting from the rupturing of an overloaded cylinder of the refined uranium on January 4, 1986. The plant was not returned to full production during the year. Uranium hexafluoride is used in the manufacture of nuclear fuel rods.

**Legislation and Government Programs.**—Control of surface coal mining was returned to the Oklahoma Department of Mines on January 1, 1986, after nearly 2 years under Federal supervision. The State system had to be revamped when the Office of Surface Mining Reclamation and Enforcement determined in April 1984 that Oklahoma's environmental standards were not adequate, as prescribed by the Surface Mining Control and Reclamation Act of 1977. Return of control to the Oklahoma Department of Mines also brought a \$671,421 Federal grant to resume inspection and enforcement of surface coal mining activities. In late November, the Office of Surface Mining awarded an additional \$815,994 to the Department of Mines.

Voters in an August election approved State Question 594, which transferred the duties of chief mine inspector to the newly reorganized Department of Mines.

On November 4, 1986, the electorate voted to raise the minimum age at which boys are allowed to work underground from 16 to 18 years and to allow women 18 years of age and older to work underground. The measure also continued the limitation on hours worked underground to 8 per day.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Ammonia.**—W. R. Grace & Co. planned to close its ammonia plant at Woodward. Ammonia, derived from phosphate rock shipped in from other States, was used in making fertilizers and explosives.

**Cement.**—Oklahoma ranked 16th among 40 portland-cement-producing States. Portland cement output and value declined;

masonry cement output rose 16%, and value, 12%.

Blue Circle Inc., Ideal Basic Industries Inc., and Lone Star Industries Inc. produced masonry and portland cements at plants in Rogers, Pontotoc, and Mayes Counties, respectively. The three firms operated two wet-process and five dry-process kilns.

Raw materials consumed were 1.9 million short tons of cement rock, 1.0 million tons of



limestone, 0.336 million tons of clay, and smaller amounts of bauxite, gypsum, iron ore, sand, shale, and various chemicals. Fuels used by the three companies to produce cement were predominantly natural gas and some bituminous coal.

Finished portland cement output and value declined less precipitously in 1986 than in 1985, although unit price per short ton dropped from \$45.68 to \$43.74. Cement production was principally gray finished portland cement, classified as "general-use and moderate-heat" type. Price of oil well cement, whose output was related to oil well drilling activities, fell slightly.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (67.2% of shipments), contractors, highway contractors, concrete product manufacturers, building material dealers, miscellaneous customers, and government agencies. Bulk shipments of portland cement from plant to terminals were transported by rail (95.3% of shipments) and by truck.

**Clays.**—Common clay and shale was mined from 14 pits in 11 of Oklahoma's 77 counties. Output and value decreased slightly from figures reported in 1985. Average unit price per short ton remained unchanged at \$2.35. Ideal Cement Co., a subsidiary of Ideal Basic Industries, was the State's leading clay producer from its pit in Pontotoc County.

Oklahoma's clay was used to manufacture common and face brick and portland cement and pottery, as lightweight aggregate for use in concrete block and structural concrete, and for highway surfacing. After a large gain in face brick manufacture in 1985, common and face brick production and clay output dropped off moderately in 1986.

**Feldspar.**—Oklahoma was one of six States reporting feldspar production. The quantity and value of output increased 11% and 15%, respectively. Unit price per short ton, after sagging in 1985, returned to a level slightly above the 1984 price. Feldspars were used in electrical insulators, enamels, glassmaking, pottery, and soaps.

**Gypsum.**—The State ranked fourth nationally in production of crude gypsum. Output increased more than 5%, but total value fell about 22% as the unit price plunged from \$7.87 to \$5.86 per short ton in 1986.

The largest of Oklahoma's six gypsum mines, USG Corp.'s mine at Southard,

Blaine County, ranked 10th in output among gypsum mines in the Nation.

The State's output of calcined gypsum continued to rise and was 22% higher in 1986 than in 1985. Unit price, however, plunged more than 40% to \$13.74 per short ton. Republic Gypsum Co.'s plant at Duke, Jackson County, was the Nation's eighth largest gypsum calcining plant. Temple-EasTex Inc. began production at a new \$20 million, 100-employee, gypsum wallboard plant near Fletcher (Comanche County), which purchased crude gypsum from Harrison Gypsum Co. Inc. in Caddo County.

**Iodine.**—Woodward Iodine Corp.'s plant in northwestern Oklahoma was the Nation's preeminent iodine producer, meeting 25% of the United States' demand for iodine. The 2-million-pound-per-year plant, owned by Asahi Glass Co. Ltd. of Toyko, Japan, operated close to capacity in 1986. Output, value, and unit price of iodine increased over 1985 figures by approximately 8%, 11%, and 3%, respectively.

The many uses of iodine ranged from the commonly known health products to color film, Geiger counters, airport luggage scanners, and cloud seeding.

**Lime.**—St. Clair Lime Co. made quicklime at its Marble City plant in Sequoyah County. Although production was down slightly, value and average unit price rose. No hydrated lime production was reported.

**Pumice.**—Axtell Mining Corp. continued to mine and process pumice (volcanic ash) at its facility near Gate, Beaver County. Unit price per short ton, after dipping steeply in 1985, rose nearly 375% to \$58.79 per ton. Abrasive uses accounted for about 20% of output, and absorbent uses, 80%.

**Salt.**—Salt production reported from Oklahoma sources increased significantly in output and value; the average unit price increased 61% to \$34.70 per short ton. All production came from Wood County.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Production of construction sand and gravel fell moderately in quantity and value from that reported in 1984; price per ton decreased \$0.19 to \$2.37. The commodity was produced by 118 companies in 50 of Oklahoma's 77 counties at 150 pits.

Anchor Industries acquired a second pit

and increased production fivefold, bringing the company to the first-rank position among the State's construction sand and gravel producers. Following Anchor Industries in order of output were The Dolese Co., Boorhem-Fields Inc., and 114 other companies, which, together, produced sand and gravel from 133 operations. Only one operation produced 900,000 to 1 million short tons per year; 61 operations produced less than 25,000 tons each.

Sand and gravel was used, in decreasing order of quantity, for concrete aggregates (29%), fill, road base cover and stabilization, asphaltic concrete, concrete products, plaster and gunite, and railroad ballast. Average unit price per short ton fell slightly from that reported for 1984 to \$2.37, compared with the national average of \$3.11 in 1986. Virtually all transported sand and gravel was moved by truck.

**Table 4.—Oklahoma: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	2,975	\$7,989	\$2.69
Plaster and gunite sands -----	120	245	2.04
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	288	867	3.01
Asphaltic concrete aggregates and other bituminous mixtures -----	427	798	1.87
Road base and coverings <sup>1</sup> -----	803	1,888	2.35
Fill -----	1,084	1,497	1.38
Snow and ice control -----	W	W	1.00
Railroad ballast -----	W	W	2.41
Other <sup>2</sup> -----	128	370	2.89
Other unspecified <sup>3</sup> -----	4,541	10,932	2.41
Total or average -----	10,366	424,585	2.37

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

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes roofing granules.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—The output of industrial sand from Oklahoma pits increased substantially over that reported for 1985. Average unit price was \$13.67 per short ton, higher than the 1984 average price but little changed from that of 1985.

U.S. Silica, a subsidiary of United States Borax & Chemical Corp., bought the Mill Creek operations (Johnston County) of Pennsylvania Glass Sand Corp. (a subsidiary of International Telephone & Telegraph Corp.) and became the State's leading industrial sand producer. Other industrial sand operations were in Muskogee and Pontotoc Counties.

**Stone.—Crushed.**—Crushed stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates from 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Preliminary estimates indicated crushed stone production decreased in quantity but increased in total value, as unit price per short ton rose from \$3.17 in 1985 to \$3.30 in 1986. The State's production came principally from limestone, but dolomite, granite, sandstone, and miscellaneous rock types

were also produced.

Six of Oklahoma's limestone quarries were among the 150 largest producers in the Nation. These were operated by Dolese Bros. Co. (a subsidiary of The Dolese Co.) in Comanche, Kiowa, and Caddo Counties; Material Producers Inc. in Murray County; Tulsa Rock Co. in Rogers County; and Standard Industries (a division of APAC-Oklahoma Inc.) in Tulsa County.

**Dimension.**—Dimension stone output increased steadily in the period 1984-86; output in 1986 was estimated to be about 73% higher than that of 1985. Unit price per short ton fell about 37%. Oklahoma was best known for a pink granite, mined in Johnston County.

**Sulfuric Acid.**—Production of sulfuric acid, recovered in smelting and refining zinc concentrates, decreased less than 1% in volume but more than 21% in value. The State's principal smelter was that of St. Joe Minerals Corp. in Bartlesville.

**Tripoli.**—Oklahoma was the second ranking of four tripoli-producing States. Output of this natural abrasive in Oklahoma declined nearly 6% from that of 1985 and 13% from that of 1984; total value declined

more than 21%. American Tripoli Co. was acquired by Processed Mineral Inc., a division of Canadian Pacific Railroads Co.

**Vermiculite (Exfoliated).**—W. R. Grace produced exfoliated vermiculite at its Oklahoma City plant from raw material shipped in from out of State. Production, sales, and unit price of the material declined significantly, as application in all uses declined but particularly the volume of material used in horticultural agriculture.

### METALS

**Gallium.**—Eagle-Picher Industries Inc. recovered and refined gallium from out-of-State primary sources and from secondary materials at its plant in Quapaw, Ottawa County. The price of gallium metal was about \$525 per kilogram in 100-kilogram lots. Gallium was a component of a new optical transistor, or chip, capable of controlling light beams.

**Iron and Steel.**—Mill Creek Mining Inc., inactive in 1986, planned to mine limonite from its Scullin pit in Murray County by March 1987.

**Uranium.**—Sequoyah Fuels awaited ap-

proval from the Nuclear Regulatory Commission to begin production of the metallic form of uranium tetrafluoride at a new facility at Gore. Metallic uranium tetrafluoride was used in the production of armor-piercing bullets and airplane counterweights.

**Zinc.**—St. Joe Minerals, a division of Fluor Corp., refined zinc at its Bartlesville refinery. The refinery had an annual capacity of 55,000 short tons of "zinc equivalent" and utilized both concentrates and secondary materials to produce zinc metal, zinc oxide, and zinc dust. Zinc metal was used primarily in galvanizing and in brass and bronze fabrication; zinc oxide in the manufacture of pharmaceutical, reprographic, and rubber products; and zinc dust in corrosion-resistant coatings. Measured in inflation-adjusted dollars, zinc prices during 1986 were at their lowest levels since 1932.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.

<sup>2</sup>Director, Oklahoma Mining & Mineral Resources Research Institute, Oklahoma Geological Survey, Norman, OK.

<sup>3</sup>Dikeman, N. J., Jr. Business Highlights. OK Bus. Bull., v. 55, issue 3, Mar. 1987, pp. 9-11.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Blue Circle Inc., a subsidiary of Blue Circle Industries Ltd. <sup>1 2</sup>	One Parkway Center 1850 Parkway Place Suite 1000 Marietta, GA 30067	Quarry and plant	Rogers.
Ideal Basic Industries Inc., Ideal Cement Co. <sup>1 2</sup>	Box 8789 Denver, CO 80201	-----do-----	Pontotoc.
Lone Star Industries Inc. <sup>1 2</sup> -----	Box 12449 Dallas, TX 75225	-----do-----	Mayes.
<b>Clays:</b>			
Acme Brick Co., a subsidiary of Justin Industries Inc.	Box 24012 Oklahoma City, OK 73124	Pits and plants	Custer and Oklahoma.
Chandler Materials Co -----	5805 East 15th St. Tulsa, OK 74102	-----do-----	Oklahoma and Rogers.
Commercial Brick Corp -----	Box 1382 Wewoka, OK 74884	Pit and plant	Seminole.
Oklahoma Brick Corp., a subsidiary of Merry Co.	Box 75368 4300 NW, 10th St. Oklahoma City, OK 73127	-----do-----	Canadian and Muskogee.
<b>Feldspar:</b>			
Arkhol Sand & Gravel Co., a division of APAC-Arkansas Inc., a subsidiary of Ashland Oil Co. <sup>2 3</sup>	Box 1401 Muskogee, OK 74401	Dredge and plant	Muskogee.
<b>Gallium and germanium:</b>			
Eagle-Picher Industries Inc.-----	Box 737 Quapaw, OK 74363	Refinery	Ottawa.
<b>Gypsum:</b>			
Harrison Gypsum Co. Inc -----	Box 336 Lindsay, OK 73052	Quarry	Caddo.
Heartland Cement Co -----	Box 428 Independence, KS 67301	-----do-----	Blaine.
Republic Gypsum Co -----	Drawer C Duke, OK 73532	Quarry and plant	Jackson.
Temple-EasTex Inc. -----	Box 101 Fletcher, OK 73541	-----do-----	Comanche.
United States Gypsum Co., a subsidiary of USG Corp.	Box 187 Southard, OK 73770	-----do-----	Blaine.

See footnotes at end of table.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Iodine:</b>			
North American Brine Resources ---	c/o Beard Oil Co. 2000 Classen Center Bldg. Oklahoma City, OK 73106	Oilfield brines and plant.	Kingfisher.
Woodward Iodine Corp., a subsidiary of Asahi Glass Co. Ltd.	Box 1245 Woodward, OK 73801	Brine field and plant.	Woodward.
<b>Lime:</b>			
St. Clair Lime Co -----	Box 569 Sallisaw, OK 74955	Mine and plant --	Sequoyah.
<b>Pumice (volcanic ash):</b>			
Axtell Mining Corp -----	Box 92 Gate, OK 73844	Open pit -----	Beaver.
<b>Salt:</b>			
Cargill Inc -----	Box 167 Freedom, OK 73842	Solar evaporation --	Wood.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Boorhem-Fields Inc. <sup>2</sup> -----	Star Route B Box 284A Kingston, OK 73439	Quarries -----	Bryan.
The Dolese Co. <sup>2</sup> -----	13 NW 13th St. Oklahoma City, OK 73101	Pits and plants---	Canadian, King- fisher, Logan, Oklahoma.
Gainesville Sand & Gravel Co --	Box 47127 Dallas, TX 75247	Pit and plant ----	Love.
Lemon Haskell Construction Co. of General Materials Inc.	Box 24044 Oklahoma City, OK 73124	Pits and plant ----	Cleveland.
<b>Industrial:</b>			
Mid-Continent Glass Sand Co ----	Box 248 Roff, OK 74865	Pit and plant ----	Pontotoc.
U.S. Silica Co -----	Box 36 Mill Creek, OK 74856	Pits and plant ----	Johnston.
<b>Stone:</b>			
<b>Crushed:</b>			
Amis Materials Co -----	Box 168 Stringtown, OK 74569	Quarry -----	Atoka.
Anchor Stone Co., a subsidiary of Anchor Industries. <sup>3</sup>	3300 North Mingo Valley Expressway Tulsa, OK 74116	----do-----	Tulsa.
Bellco Materials Inc. <sup>3</sup> -----	Box 466 Nowata, OK 74048	Quarries -----	Nowata, Rogers, Washington.
Material Producers Inc -----	Box 577 Norman, OK 73070	Quarry -----	Murray.
McNabb Stone Co., a division of McNabb Coal Co. Inc.	Drawer C Catoosa, OK 74015	Quarries -----	Rogers and Wagoner.
Meridian Aggregates Co., a sub- sidiary of Burlington Northern Railroad.	Box 86 Mill Creek, OK 74856	Quarry -----	Johnston.
The Quapaw Co -----	Box 72 Drumright, OK 74030	Quarries -----	Creek and Pawnee.
Seonor Rock & Sand Co., a sub- sidiary of Hallet Construction Co.	Box 1549 Norman, OK 73070	Quarry -----	Murray.
Standard Industries, a division of APAC-Oklahoma Inc.	Box 589670 Tulsa, OK 74158	Quarries -----	Cherokee, Kay, Mayer, Tulsa.
Tulsa Rock Co., a subsidiary of The McMichael Co. of Koppers Co. Inc.	Box 3878 Tulsa, OK 74102	Quarry -----	Rogers.
<b>Dimension:</b>			
Bodie L. Anderson Quarries Inc --	Box 106 Mill Creek, OK 74856	----do-----	Johnston.
Wilson Miller -----	Route 1 Hackett, AR 72937	----do-----	Le Flore.
Pontotoc Stone Co -----	1434 NW 30th St. Oklahoma City, OK 73118	----do-----	Johnston.
TDM Quarry Co -----	Route 5, Box 72 McAlester, OK 74501	----do-----	Pittsburg.
Willis Granite Co. Inc -----	Box 188 Granite, OK 73547	----do-----	Greer.
<b>Tripoli:</b>			
American Tripoli Co -----	Box 489 Seneca, MO 64865	Mines -----	Ottawa.
<b>Zinc:</b>			
St. Joe Minerals Corp., a division of Fluor Corp.	Box 579 Bartlesville, OK 74005	Refinery -----	Washington.

<sup>1</sup>Also clays.

<sup>2</sup>Also stone.

<sup>3</sup>Also sand and gravel.



# The Mineral Industry of Oregon

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

By W. L. Rice<sup>1</sup> and Ronald P. Geitgey<sup>2</sup>

Oregon's nonfuel mineral production value dropped to \$126 million in 1986, a decrease of 3% from that of 1985. Substantial reductions in the value of cement and nickel production were largely responsible for the decrease. Industrial minerals accounted for nearly all of the nonfuel mineral production value reported for 1986. Stone was the leading commodity in terms

of value, followed by construction sand and gravel, cement, and lime; these commodities accounted for nearly 96% of the State's total nonfuel mineral value. Oregon ranked 39th in the Nation in value of nonfuel minerals produced in 1986, down from 36th in 1985. The State ranked 35th in the value of its industrial mineral production in 1986.

Table 1.—Nonfuel mineral production in Oregon<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	189	\$288	188	\$285	204	\$289
Gem stones -----	NA	*400	NA	*350	NA	350
Nickel (recoverable content of ores, etc.) short tons	14,540	W	6,127	W	1,175	W
Sand and gravel (construction) thousand short tons	12,776	37,117	*12,500	*36,800	13,441	42,597
Stone (crushed) ----- do	*12,500	*37,500	15,336	54,244	*15,100	*53,400
Talc and (soapstone) ----- do	( <sup>2</sup> )	66	( <sup>2</sup> )	30	( <sup>2</sup> )	41
Combined value of cement, diatomite, gold, lime, pumice, silver (1984), stone (dimension), and values indicated by symbol W	XX	45,081	XX	38,587	XX	29,755
Total -----	XX	120,402	XX	130,296	XX	126,432

<sup>1</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>3</sup>Less than 1/2 unit.

**Table 2.—Nonfuel minerals produced in Oregon in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Baker	Cement, stone (crushed), clays.
Benton	Stone (crushed).
Clackamas	Do.
Clatsop	Do.
Columbia	Do.
Coos	Do.
Crook	Do.
Curry	Do.
Deschutes	Pumice, stone (crushed).
Douglas	Nickel, stone (crushed).
Hood River	Stone (crushed).
Jackson	Stone (crushed), talc.
Jefferson	Stone (crushed).
Josephine	Gold (lode).
Klamath	Stone (crushed), clays.
Lake	Diatomite, stone (crushed).
Lane	Stone (crushed).
Lincoln	Do.
Linn	Stone (crushed), gold.
Malheur	Lime.
Marion	Stone (crushed).
Morrow	Do.
Multnomah	Lime, stone (crushed), clays.
Polk	Stone (crushed).
Tillamook	Do.
Umatilla	Do.
Wasco	Do.
Washington	Do.
Yamhill	Do.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—In late December, the M. A. Hanna Co. permanently closed its integrated nickel mine and smelter, near Riddle, Douglas County. Reduced production costs were insufficient to offset consistently depressed nickel prices. The Hanna facility, which commenced production in 1954, was the only domestic nickel mine and smelter complex; it was an economic mainstay of southern Douglas County.

Although aluminum production in the State remained at a low level throughout 1986, at yearend a new company, Northwest Aluminum Co. of Portland, had leased and restarted the shutdown Martin Marietta Aluminum Inc. reduction plant at The Dalles.

The titanium industry was depressed in 1986, and Oregon Metallurgical Corp. (OREMET), Albany, operated at a loss.

Near yearend, Nippon Kokan K.K., a major Japanese steelmaker and diversified industrial firm, announced plans to site a \$60 million polycrystalline silicon plant in Oregon's Willamette Valley. The plant would produce the basic material for computer chips.

The Gorda Ridge Technical Task Force continued its search for polymetallic sulfide

deposits off the coast of southern Oregon and northern California, within the 200-mile-wide U.S. Exclusive Economic Zone. Four weeks were spent in 1986 in exploring two major volcanic domes along the Gorda Ridge, using the U.S. Navy's *Sea Cliff* deep-submergence vehicle. Research efforts resulted in the discovery of high-grade deposits containing copper, gold, lead, silver, and zinc.

The Portland-based Wagner Mining Equipment division of Paccar Inc., a major producer of wheeled, underground ore-tramming machinery, laid off 10% of its 325-employee work force in midyear. The company has had a 50% decline in sales since 1980, and the plant operated at about one-half capacity in 1986. Recently, the company has been producing about 700 underground vehicles per year.

**Exploration Activities.**—Exploration activity in Oregon in 1986 declined slightly from the 1985 level. There was some exploration for industrial minerals, but most efforts were directed toward precious metals in both massive sulfide and epithermal systems. Many of the precious metal investigations were preliminary evaluations and regional reconnaissance programs, rather than work on specific targets.

Quartz Mountain Gold Corp. continued exploration at its 10,000-acre Quartz Butte-Crone Hill-Angels Camp epithermal gold property in Lake County. More than 75,000 feet of drilling confirmed reserve estimates of 10 to 15 million tons of ore grading 0.04 troy ounce of gold per short ton.

Baretta Mines Ltd. and Rayrock Mines Inc. worked on the Turner-Albright massive sulfide deposit in Josephine County; more than 60,000 feet of diamond drilling has established reserves of 3.3 million tons of ore containing 376,000 ounces of gold and 1.46 million troy ounces of silver. The ore body has an average grade of 0.114 ounce of gold per ton, 0.443 ounce of silver per ton, 1.46% copper, 3.33% zinc, and 0.055% cobalt.

Exploration in Josephine County included Kennecott at the Almeda Mine and Amselco Minerals Inc. at the Goff Mine, both massive sulfide deposits.

In Baker County, American Copper & Nickel Co. drilled on NERCO Minerals Co.'s Ibox gold property, the Manville International Group drilled on its Grouse Spring copper-silver-zinc skarn deposit, and Supreme Perlite Co. explored perlite deposits on Dooley Mountain.

Table 3.—Indicators of Oregon business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	2,676	2,686	2,698
Total civilian labor force -----	do	1,335	1,315	1,347
Unemployment -----	percent	9.4	8.8	8.5
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	1.6	1.5	1.4
Manufacturing total -----	do	201.1	199.3	196.7
Primary metal industries -----	do	9.1	8.8	8.5
Stone, clay, and glass products -----	do	2.7	3.1	3.2
Chemicals and allied products -----	do	2.0	2.1	2.1
Petroleum and coal products -----	do	.5	.4	.4
Construction -----	do	30.2	33.1	34.1
Transportation and public utilities -----	do	57.1	57.3	57.0
Wholesale and retail trade -----	do	253.0	258.6	268.1
Finance, insurance, real estate -----	do	65.4	66.8	69.6
Services -----	do	204.5	215.6	230.2
Government and government enterprises -----	do	194.1	197.7	199.3
Total <sup>1</sup> -----	do	1,006.9	1,030.0	1,056.5
<b>Personal income:</b>				
Total -----	millions	\$32,246	\$34,075	\$35,955
Per capita -----	do	\$12,048	\$12,687	\$13,328
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	39.2	38.7	39.0
Total average hourly earnings, production workers -----	do	\$10.4	\$10.5	\$10.6
<b>Earnings by industry:<sup>2</sup></b>				
Farm income -----	millions	\$583	\$631	\$765
Nonfarm -----	do	\$22,058	\$23,393	\$24,670
Mining total -----	do	\$80	\$98	\$89
Metal mining -----	do	\$2	\$2	\$3
Nonmetallic minerals except fuels -----	do	\$25	\$27	\$19
Manufacturing total -----	do	\$5,263	\$5,346	\$5,515
Primary metal industries -----	do	\$309	\$300	\$303
Stone, clay, and glass products -----	do	\$78	\$85	\$93
Chemicals and allied products -----	do	\$59	\$62	\$62
Petroleum and coal products -----	do	\$16	\$12	\$16
Construction -----	do	\$1,108	\$1,221	\$1,323
Transportation and public utilities -----	do	\$1,829	\$1,867	\$1,922
Wholesale and retail trade -----	do	\$4,158	\$4,355	\$4,596
Finance, insurance, real estate -----	do	\$1,130	\$1,209	\$1,380
Services -----	do	\$4,539	\$5,018	\$5,436
Government and government enterprises -----	do	\$3,741	\$4,071	\$4,162
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup> -----	do	8,055	11,297	10,662
Value of nonresidential construction <sup>3</sup> -----	millions	\$539.6	\$582.6	\$590.6
Value of State road contract awards <sup>4</sup> -----	do	\$217.1	\$255.9	\$264.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	609	709	626
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$120.4	\$130.3	\$126.4
Value per capita -----	do	\$45	\$49	\$47

<sup>P</sup>Preliminary. <sup>F</sup>Revised.

<sup>1</sup>Data may not add to totals shown because of independent rounding.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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



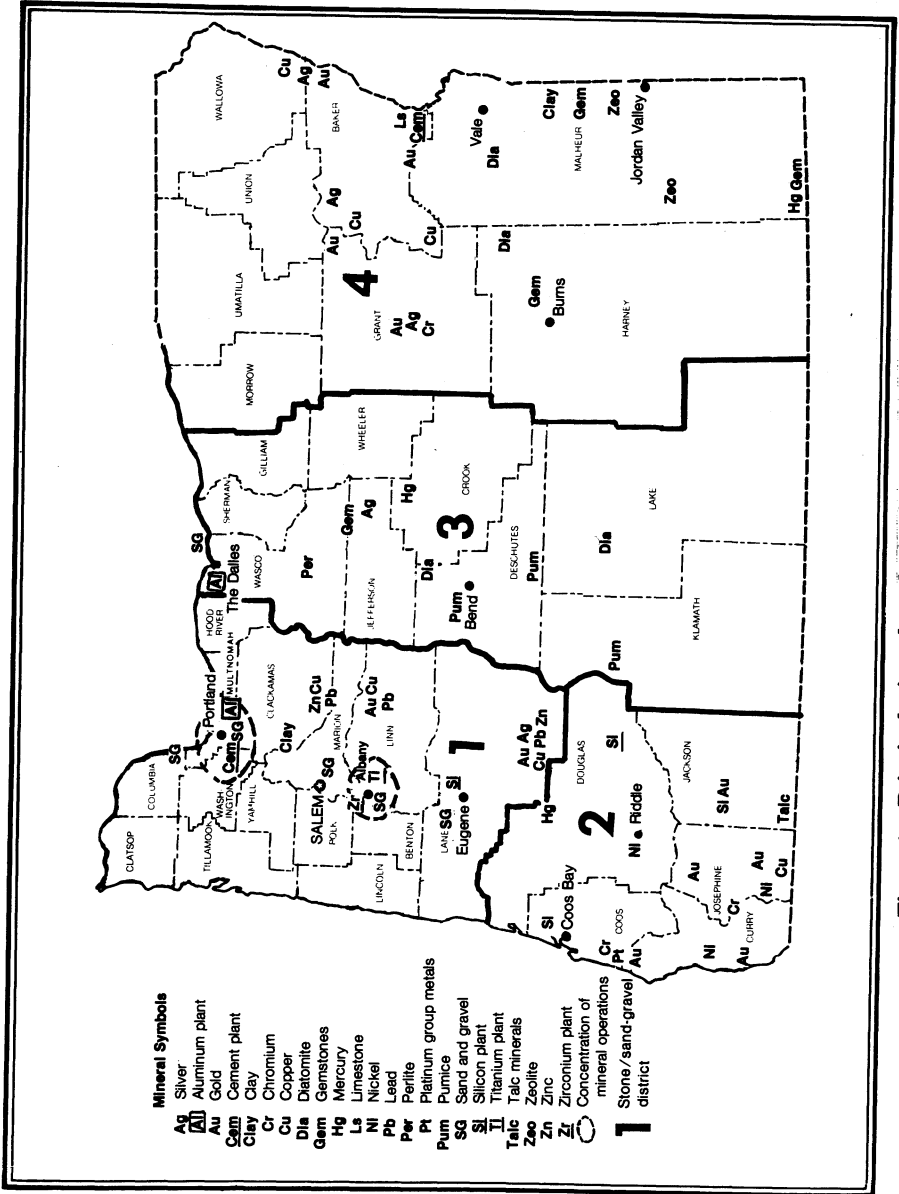


Figure 1.—Principal mineral-producing localities in Oregon.

Tenneco Minerals Co., in joint venture with Western States Minerals Corp., completed testing of a perlite deposit on Tucker Hill in Lake County, and Alaska Pacific Oregon Ltd. conducted a bentonite sampling program east of Prineville in Crook County. Endurance Minerals evaluated hydrothermally altered volcanic rocks in the Foster Creek area of Douglas County for use as a soil amendment and micronutrient source.

**Environment.**—Since 1977, the disposal of sludge contaminated with radium, uranium, and other radioactive isotopes has been an environmental issue in Oregon. In 1986, late November rains ended for the year the moving of radioactive uranium mill tailings from the edge of Lakeview, Lake County, to a permanent burial site 7-1/2 miles distant. A total of 630,000 cubic yards of tailings was scheduled to be moved by late 1987, at a cost of \$16.4 million.

Teledyne Wah Chang Albany (TWCA) studied a method to render 90,000 cubic yards of slightly radioactive process sludge inert by electrically fusing it into glass. The sludge, stored at the company's Albany metals plant, was a byproduct of zirconium refining by a no-longer-used process. Electrical fusion, employing a large number of buried electrodes, will melt and fuse the sludge into large blocks of inert glass.

**Legislation and Government Programs.**—A proposal to sell the Federal Government's Bonneville Power Administration (BPA) was abandoned after strong opposition by the Northwestern States' Governors and congressional delegations. The Northwest Power Planning Council calculated that the sale of BPA to private interests would raise wholesale power rates by 71.1%, thereby driving most of the Northwest's aluminum companies and other electricity-dependent industries out of business.

An unsuccessful 1985 proposal for a large-scale interagency land exchange between the U.S. Forest Service and the Bureau of Land Management (BLM) was revived in early 1986. The scaled-down plan called for the BLM to transfer 461,000 acres in Oregon to the Forest Service, and to assume management of about 27,000 acres of National Forest land. Administration of the defunct Oregon and California Railroad lands in western Oregon would have remained with the BLM, and the Forest Service would have assumed responsibility for managing subsurface minerals on about 18 million

acres in the State. The proposal concerned mining interests because it could change mineral leasing management policy on the affected lands.

Proposed legislation was carried over from 1985 that would more than double the 220,000 acres of existing wilderness in the Hells Canyon National Recreation Area, in northeastern Oregon and adjoining parts of Idaho and Washington. Widespread regional opposition by lumbering, ranching, motorized recreationists, and mining interests caused the proposed bill to be dropped.

Legislation creating the 277,000-acre Columbia River Gorge National Scenic Area was signed into law in November. The law established joint State-U.S. Forest Service management of the 60-mile-long gorge, where the Columbia River cuts through the Cascade Mountains between Oregon and Washington. The law, which severely restricts commercial development in the gorge, prohibits new surface mining or hydroelectric projects in the scenic area.

Mineral leasing payments to Oregon by the BLM totaled about \$1.08 million in 1986.

The Oregon Department of Geology and Mineral Industries (DOGAMI) continued investigations of industrial minerals in Oregon, including the State's talc and limestone resources. A geochemical survey of a 425-square-mile area in Jefferson and Crook Counties identified several areas that would justify more intensive exploration efforts for hot-spring-type gold and other metal deposits.

Six reports on the geology and biology of the offshore Gorda Ridge were prepared by the Oregon State University (OSU) College of Oceanography and released as open file reports by DOGAMI. Also open filed by DOGAMI was a comprehensive inventory of data on coastal heavy-mineral-bearing "black sands," a potential source of such strategic metals as chromium and titanium.

A comprehensive bibliography of the ocean floor off Oregon and of the continental margin was published as Map GMS-39 in DOGAMI's Geological Map Series. Publication of a companion geologic map of the ocean floor off Oregon was announced later in the year by DOGAMI as Map GMS-42. Both maps contributed to the continuing exploration of the State's offshore areas, and both were the products of a joint effort among DOGAMI, OSU, and the U.S. Minerals Management Service.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

The 1986 value of industrial mineral production in Oregon decreased nearly 3% from that recorded in 1985. Gains in the value of diatomite and construction sand and gravel production were insufficient to offset decreases in the value of cement, lime, and crushed stone.

**Cement.**—The quantity of cement produced in Oregon in 1986 decreased nearly 7% from that of 1985. The State's only cement producer, Ash Grove Cement West Inc., operated its limestone quarry and cement plant near Durkee, Baker County, throughout the year. Ash Grove sold the site of its former Lake Oswego cement plant. Ash Grove's limestone processing operations were moved to the Port of Portland's Rivergate Industrial Park, and the cement transfer station was relocated to another site.

Portland cement produced in the State was used by ready-mixed concrete companies (80%); concrete product manufacturers (11%); highway contractors (4%); building material dealers (3%); and other contractors, government agencies, and miscellaneous customers (2%). Raw materials consumed in cement manufacture were locally mined calcareous cement rock, clay, and shale, and imported iron ore and gypsum. The one-kiln, dry-process cement plant used natural gas and coal for fuel and purchased electricity for energy. Plant-to-terminal shipment was in bulk by rail; shipment in bulk and containers from terminal to customers was by truck.

**Clays and Zeolite.**—Oregon's 1986 clay production increased by nearly 9% in quantity, although the value was up only slightly from that of 1985. Common clay, used chiefly in bricks, ceramic tile, and cement, was mined from five deposits in Baker, Klamath, and Multnomah Counties.

Teague Mineral Products Co. produced bentonite clay near Adrian in Malheur County; the material was sold for drilling mud and as a sealant for ponds, ditches, and waste disposal sites. Bentonite was also mined by Central Oregon Bentonite Co. and Oregon Sun Ranch from pits on Camp Creek in Crook County. Central Oregon Bentonite's product was used in drilling mud and pond sealant, and Oregon Sun Ranch's bentonite was sold for pet litter.

Teague also produced the zeolite mineral clinoptilolite from its mine on Succor Creek in Malheur County. Most of the zeolite was sold as pet litter, with smaller amounts marketed as odor-control products, fungicide carriers, and ammonia absorbent in aquarium systems. Teague shipped a 1-ton sample of clinoptilolite to Bikini Atoll in the South Pacific to evaluate its absorption characteristics in preventing cesium uptake by food crops grown in soils contaminated by nuclear testing.

**Diatomite.**—Oregon's diatomite production increased by nearly 24% in quantity and slightly more than 44% in value from that reported in 1985. The State ranked fourth in the Nation for diatomite production in 1986.

Eagle-Picher Industries Inc. commenced production in midsummer at its \$13.5 million Celatom diatomite processing plant near Vale, in Malheur County. Diatomite ore was processed by crushing, grinding, air classification, and flux calcining into filter aids for food products, fuels, and pharmaceuticals. The Celatom facility increased Eagle-Picher's diatomite production capacity by one-third. The diatomite was open pit mined from sites in the Juntura Basin near Drewsey in Harney and Malheur Counties. Mining and minesite stockpiling were done in the summer months, and the ore was truck-hauled 70 miles to the Vale plant.

Oil-Dri Production Co. continued diatomite production at its open pit mine and processing plant in Christmas Valley, Lake County. The diatomite was packaged as pet litter for several companies under various brand names.

**Lime.**—Lime production in Oregon for 1986 decreased about 1% in quantity and slightly more than 4% in value from that recorded in 1985. Ash Grove Cement in Multnomah County and Amalgamated Sugar Co. at Nyssa, Malheur County, produced throughout the year. Nearly 83% of reported production was quicklime; Ash Grove was responsible for all the State's hydrated lime production. All of Amalgamated Sugar's production was used in-house for sugar refining; Ash Grove's lime was used for industrial applications and in sugar processing.

**Perlite (Expanded).**—Supreme Perlite manufactured expanded perlite at Portland, Multnomah County. The quantity and

value of its 1986 output were the same as those reported in 1985.

**Pumice.**—Oregon ranked second in the Nation for pumice production in 1986. The quantity produced was down about 2%, but the value increased by less than 1% from that of 1985. Cascade Pumice Co. and Central Oregon Pumice Co. produced pumice from two open pit mines in the Bend area, Deschutes County. Processed pumice from the two operations was used for lightweight concrete aggregate (49%), building and decorative block (36%), landscaping (8%), road construction and maintenance (5%), and roofing (2%).

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The 1986 output of construction sand and gravel in Oregon increased about 8% in quantity and nearly 16% in value, and the

unit value was up nearly 15% from that reported for 1984, when the last complete canvass was taken. The largest increases were in the concrete aggregate, concrete products, and asphaltic concrete aggregate production categories; there was a substantial decrease in the road base and coverings use category for the year. Five counties—Clackamas, Columbia, Jackson, Marion, and Multnomah accounted for 56% of the State's total construction sand and gravel production tonnage. Major uses were for concrete aggregates (23%), concrete products (18%), asphaltic concrete aggregates (27%), and other (32%). The bulk of Oregon's construction sand and gravel production was transported by truck; lesser quantities were moved by waterways and other methods.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel production statistics by districts for some States. Table 5 presents end-use data for construction sand and gravel produced in the four Oregon districts that are outlined in figure 1.

**Table 4.—Oregon: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	3,029	\$10,996	\$3.63
Plaster and gunite sands -----	53	267	5.04
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	2,472	9,326	3.77
Asphaltic concrete aggregates and other bituminous mixtures -----	2,898	9,876	3.41
Road base and coverings <sup>1</sup> -----	430	320	2.14
Fill -----	87	332	3.82
Railroad ballast -----	192	1,240	6.46
Other -----	330	713	2.16
Other unspecified <sup>2</sup> -----	3,950	8,928	2.26
Total <sup>3</sup> or average -----	13,441	\$42,597	3.17

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Includes 1,298,000 short tons valued at \$1,402,000 not reported by county.

<sup>4</sup>Data do not add to total shown because of independent rounding.

**Table 5.—Oregon: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	2,679	9,601	317	1,158	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures -----	1,852	7,324	540	1,657	--	--	80	345
Road base and coverings <sup>2</sup> -----	1,925	6,583	488	1,724	96	273	390	1,296
Fill -----	364	772	64	144	W	W	W	W
Snow and ice control -----	61	251	W	W	--	--	W	W

See footnotes at end of table.

**Table 5.—Oregon: Construction sand and gravel sold or used by producers in 1986, by use and district —Continued**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Railroad ballast -----	---	---	W	W	--	--	W	W
Other -----	330	713	---	---	---	---	---	---
Other unspecified <sup>3</sup> -----	2,162	6,069	378	1,012	5	26	412	2,248
Total <sup>4, 5</sup> -----	9,372	31,311	1,787	5,695	101	299	882	3,889

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

<sup>1</sup>Includes plaster and gunit sands.

<sup>2</sup>Includes road and other stabilization (cement).

<sup>3</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

<sup>5</sup>Excludes 1,298,000 short tons valued at \$1,402,000 not reported by county.

**Industrial.**—CoosSand Corp. produced silica sand from its property on Coos Bay, Coos County. The sand was rail-shipped to a processing plant near Portland and sold for sandblasting sand, for railroad traction sand, and for the production of colored glass containers.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Hanna produced a limited amount of silica from its Quartz Mountain quarry in Douglas County for use in the company's nickel smelter. Silica production from the operation ceased upon permanent closure of the smelter at yearend.

Bristol Silica and Limestone Co., at Gold Hill, Jackson County, produced crushed quartz for decorative granules, abrasives, poultry grit, and filtration medium. The production of metallurgical silica for silicon metal was discontinued.

**Talc (Soapstone).**—Steatite of Southern Oregon Inc. produced high-grade, variegated-colored soapstone from its southern Jackson County property. The soapstone product was marketed on a worldwide basis for art carving and other specialty uses. Production for 1986 increased by nearly 35% in quantity and almost 37% in value from that of 1985.

## METALS

**Aluminum.**—Primary aluminum production in the State decreased by nearly 19% in quantity and value from that reported in 1985. The worldwide oversupply and resultant depressed aluminum prices carrying through from mid-1984 adversely affected Oregon's aluminum industry, which operated at about 42% of rated capacity during

1986. An additional local adverse factor was escalated electric power rates, which had increased 800% over the previous 5 years. In midyear, the BPA announced availability of a variable power rate that linked the smelter's power costs to the price of aluminum. The Federal Energy Regulatory Commission gave an interim approval to the variable rate and allowed the rate to take effect on August 1.

Reynolds Metals Co., the State's only aluminum producer throughout 1986, operated its Troutdale smelter at 42% of rated capacity, producing about 53,000 short tons of aluminum ingot during the year.

Northwest Aluminum Inc. signed a lease-purchase agreement in September with Martin Marietta Aluminum for Martin's smelter at The Dalles. The 90,000-short-ton-per-year plant had been idle since shutdown at yearend 1984. Northwest negotiated a new union contract with profit-sharing provisions, signed with BPA for the variable power rate, and secured a tolling contract with Clarendon Ltd. By early December, the smelter was operating one of its two potlines and producing at a 45,000-ton-per-year capacity. The new operation employs 181 people, contrasted with the maximum 600-employee work force in place prior to the 1984 shutdown.

**Columbium, Hafnium, Tantalum, and Zirconium.**—TWCA was listed among seven major domestic processors and/or producers of columbium and/or tantalum in 1986. The company was a major producer of columbium metal, columbium pentoxide, and ferrocolumbium during the year at its Albany plant.

TWCA continued to be the leading producer of zirconium and hafnium in the Nation. The zirconium was used in nuclear power reactors, in photographic flash cubes, and for corrosion-resistant chemical indus-

try applications. Hafnium, derived as a byproduct of zirconium processing, was used for control rods in nuclear reactors.

TWCA, which has 1,300 employees and an annual payroll of \$52 million, was the largest private employer in Linn County and the ninth largest in Oregon in 1986.

**Copper, Gold, Lead, and Silver.**—A small amount of gold production was reported by Geo Gold & Silver Ltd. from the Irish Girl vein of the Greenback Mine in Josephine County. The 900 level of the Greenback Mine was rehabilitated, and some drifting was done on the western extension of the Greenback vein.

Silver King Mines Inc. mined and stockpiled 4,000 short tons of gold-copper ore at its Iron Dyke Mine in Baker County. The company planned to process the ore at its Copper Cliff, ID, mill.

Hereford Mining Inc. reported placer gold production from its Pine Creek Mine in Baker County. Gold was recovered from bench gravels by small-scale mechanical and hand methods. Other placer operations were active in Baker County on Burnt River, Clarks Creek, and Deer Creek. Several small-scale seasonal placer mines were operated in Josephine County on Josephine Creek and its tributaries; on Sucker Creek, Althouse Creek, and Illinois River tributaries, in the Galice area, also in Josephine County; and on Coffee Creek in Douglas County.

Bergsøe Metals Corp. closed its secondary lead smelter at St. Helens, Columbia County, in midyear. The 35,000-ton-per-year-capacity plant reprocessed lead from storage batteries; the closure left the west coast with only two major secondary lead producers. Reasons for the closure were the company's inability to obtain federally mandated environmental liability insurance and controversy with the Oregon Department of Environmental Quality over potential ground water pollution by heavy metals.

**Nickel.**—Hanna began the year working on problems with the newly installed \$13 million wet-screening plant at its nickel mine and smelter near Riddle, Douglas

County. The operation had closed in late December 1985 owing to problems with the new beneficiation and ore handling system. The mine was reopened in early 1986 and closed again in May; the smelter reopened at one-half capacity in June, working on stockpiled ore. In mid-August, Hanna closed the smelter indefinitely; depressed nickel prices made the operation uneconomic. The company announced permanent closure of the operation in early January 1987. The nickel mine and smelter, which opened in 1954, employed as many as 600 workers during the peak of operations in the 1970's; about 170 employees were working at shut-down. Hanna's Riddle operation was the only integrated nickel mine and smelter to operate in the United States.

**Titanium.**—Albany Titanium Inc. (ALTi) continued a pilot plant operation to produce titanium sponge and powder from ilmenite, using the continuous flow ALTi-Oxy process. In midyear, ALTi announced plans to begin construction in 1987 on the first commercial plant to produce titanium from ilmenite ore. The plant, estimated to cost \$60 million to \$80 million, would produce 150 million to 200 million pounds of titanium sponge per year. Possible plantsites would be in Alabama, Florida, Mississippi, or Texas.

In October, ALTi agreed to award General Electric's Aircraft Engine Group a minority interest in its high-purity titanium operation. Under the first phase of the agreement, the companies would jointly develop and evaluate powdered titanium alloys for applications in advanced jet engines. Under the second and third phases, ALTi would begin its expansion program and General Electric could take up to a 20% interest in the company.

OREMET produced titanium metal and titanium mill products at its Albany plant. Depressed titanium markets and prices led to OREMET declaring a loss for the year.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Spokane, WA.

<sup>2</sup>Industrial minerals geologist, Oregon Department of Geology and Mineral Industries, Portland, OR.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum:</b>			
Reynolds Metals Co -----	5100 NE. Sundial Rd. Troutdale, OR 97060	Smelter -----	Multnomah.
<b>Cement:</b>			
Ash Grove Cement West Inc. <sup>1</sup> -----	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	Plants and quarries.	Baker.
<b>Diatomite:</b>			
Eagle-Picher Industries Inc -----	Graham Blvd. Vale, OR 97918	Surface mine and plant.	Harney and Malheur.
Oil-Dri Production Co -----	Box 191 Christmas Valley, OR 97638	-----do-----	Lake.
<b>Lime:</b>			
Amalgamated Sugar Co -----	Box 1766 Nyssa, OR 97913	Plant -----	Malheur.
Ash Grove Cement West Inc -----	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	-----do-----	Multnomah.
<b>Nickel:</b>			
M. A. Hanna Co -----	Box 85 Riddle, OR 97469	Surface mine and smelter.	Douglas.
<b>Perlite (expanded):</b>			
Supreme Perlite Co -----	4600 North Suttle Rd. Portland, OR 97217	Plant -----	Multnomah.
<b>Pumice:</b>			
Cascade Pumice Co -----	Box 1087 Bend, OR 97701	Pit -----	Deschutes.
Central Oregon Pumice Co -----	5 NW. Greenwood Ave. Bend, OR 97701	Pit -----	Do.
<b>Sand and gravel (construction):</b>			
Cascade Aggregates Inc -----	Box 1225 Scappoose, OR 97056	Pit and plant --	Columbia.
River Bend Sand & Gravel Co -----	Box 149 Oregon City, OR 97045	Pit -----	Marion.
Ross Island Sand & Gravel Co -----	4129 SE. McLoughlin Blvd. Portland, OR 97202	Pit and plant --	Multnomah.
U.S. Forest Service -----	319 SW. Pine St. Portland, OR 97208	Pits -----	Various.
Western Pacific Construction Materials Co.	3510 SW. Bond Ave. Portland, OR 97201	Pit and plant --	Multnomah.
<b>Talc (soapstone):</b>			
Steatite of Southern Oregon Inc -----	2891 Elk Lane Grants Pass, OR 97526	Surface mine and mill.	Josephine.
<b>Titanium:</b>			
Oregon Metallurgical Corp -----	Box 580 Albany, OR 97321	Smelter and fabricating plant.	Linn.
<b>Zeolite:</b>			
Teague Mineral Products Co. <sup>2</sup> -----	Box 35-C, Route 2 Adrian, OR 97901	Surface mine and plant.	Malheur.
<b>Zirconium:</b>			
Teledyne Wah Chang Albany <sup>3</sup> -----	1600 NE. Old Salem Rd. Albany, OR 97321	Smelter and fabricating plant.	Linn.

<sup>1</sup>Also clays, pumicite, and crushed stone.<sup>2</sup>Also bentonite.<sup>3</sup>Also columbium, hafnium, tantalum, and vanadium.

# The Mineral Industry of Pennsylvania

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

By L. J. Prosser, Jr.,<sup>1</sup> and S. W. Berkheiser, Jr.<sup>2</sup>

The value of nonfuel mineral production in Pennsylvania was \$843 million in 1986, ranking the State ninth nationally. Value increased by about \$39 million over that of 1985 despite production losses in three of the State's leading commodities. Higher prices for most commodities, along with an increase in cement production, resulted in a

record-high value for the second consecutive year.

Although the State's nonfuel minerals sector continued to benefit from construction industry demand, both the coal and steel industries reported their lowest production totals of the decade.

Table 1.—Nonfuel mineral production in Pennsylvania<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Cement:</b>						
Masonry ----- thousand short tons. . . . .	298	\$20,849	303	\$20,970	391	\$26,688
Portland ----- do. . . . .	5,735	281,590	5,535	288,036	6,290	324,187
Clays <sup>2</sup> ----- do. . . . .	963	4,050	1,142	5,293	1,284	5,061
Gem stones ----- do. . . . .	NA	*5	NA	*5	NA	5
Lime ----- thousand short tons. . . . .	1,620	90,182	1,492	85,269	1,417	81,234
Peat ----- do. . . . .	24	693	21	602	19	532
<b>Sand and gravel:</b>						
Construction ----- do. . . . .	14,472	64,285	*17,000	*74,000	15,373	68,880
Industrial ----- do. . . . .	W	W	693	9,846	688	10,091
<b>Stone:</b>						
Crushed ----- do. . . . .	*56,200	*228,000	64,765	310,859	*63,700	*317,100
Dimension ----- do. . . . .	†*93	†*7,026	51	8,214	*72	*8,100
Combined value of clays (kaolin), mica (scrap), tripoli (1986), and value indicated by symbol W	XX	12,701	XX	1,380	XX	1,185
<b>Total</b> -----	XX	†709,381	XX	804,474	XX	843,058

\*Estimated. †Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes kaolin; value included with "Combined value" figure.



Table 2.—Nonfuel minerals produced in Pennsylvania in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Adams	Lime, stone (crushed), clays, mica (scrap).
Allegheny	Cement, stone (crushed), clays, sand (industrial).
Armstrong	Stone (crushed), clays.
Bedford	Stone (crushed).
Berks	Cement, stone (crushed), clays.
Blair	Stone (crushed).
Bucks	Stone (crushed), stone (dimension), clays.
Butler	Lime, stone (crushed), cement.
Carbon	Sand (industrial).
Centre	Lime, stone (crushed).
Chester	Stone (crushed), stone (dimension), clays.
Clearfield	Clays, stone (crushed).
Clinton	Stone (crushed), clays.
Columbia	Stone (crushed).
Cumberland	Do.
Dauphin	Do.
Delaware	Do.
Erie	Peat.
Fayette	Stone (crushed).
Franklin	Do.
Fulton	Do.
Huntingdon	Sand (industrial), stone (crushed).
Jefferson	Clays, stone (crushed).
Juniata	Stone (crushed).
Lackawanna	Stone (crushed), peat.
Lancaster	Stone (crushed), clays.
Lawrence	Cement, stone (crushed), clays, peat.
Lebanon	Stone (crushed), lime.
Lehigh	Cement, stone (crushed), stone (dimension).
Luzerne	Stone (crushed), peat.
Lycoming	Stone (crushed).
McKean	Do.
Mercer	Do.
Mifflin	Do.
Monroe	Stone (crushed), clays, peat.
Montgomery	Stone (crushed), lime, stone (dimension).
Montour	Stone (crushed).
Northampton	Cement, stone (crushed), stone (dimension).
Northumberland	Stone (crushed), clays.
Perry	Stone (crushed).
Pike	Do.
Schuylkill	Do.
Snyder	Do.
Somerset	Do.
Susquehanna	Stone (crushed), stone (dimension).
Tioga	Stone (crushed).
Union	Do.
Venango	Do.
Wayne	Stone (dimension).
Westmoreland	Stone (crushed).
York	Stone (crushed), cement, lime, clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Pennsylvania business activity

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	11,890	11,863	11,888
Total civilian labor force -----	do.	5,479	5,528	5,634
Unemployment -----	percent	9.1	8.0	6.8
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup> -----	thousands	38.6	36.3	33.6
Nonmetallic minerals except fuels -----	do.	4.0	4.6	4.8
Coal mining -----	do.	29.1	26.1	24.2
Oil and gas extraction <sup>1</sup> -----	do.	5.4	5.6	4.5
Manufacturing total -----	do.	1,121.9	1,089.5	1,049.1
Primary metal industries -----	do.	117.9	104.1	90.6
Stone, clay, and glass products -----	do.	49.0	47.9	47.1
Chemicals and allied products -----	do.	59.2	59.6	58.4
Petroleum and coal products -----	do.	13.0	12.7	10.7
Construction -----	do.	175.8	187.1	202.4
Transportation and public utilities -----	do.	244.2	240.6	240.0
Wholesale and retail trade -----	do.	1,033.1	1,067.4	1,094.9
Finance, insurance, real estate -----	do.	253.5	263.1	277.3
Services -----	do.	1,114.9	1,166.1	1,217.6
Government and government enterprises -----	do.	672.9	680.2	679.6
Total <sup>2</sup> -----	do.	4,654.8	4,730.3	4,794.5
<b>Personal income:</b>				
Total -----	millions	\$151,457	\$160,627	\$169,392
Per capita -----	do.	\$12,738	\$13,540	\$14,249
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do.	40.2	39.9	40.2
Mining (nonmetallic minerals, except fuels) -----	do.	44.6	45.0	45.9
Total average hourly earnings, production workers -----	do.	\$9.3	\$9.6	\$9.7
Mining (nonmetallic minerals, except fuels) -----	do.	\$9.3	\$9.7	\$9.9
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$982	\$937	\$1,055
Nonfarm -----	do.	\$104,604	\$110,809	\$117,132
Mining total -----	do.	\$1,701	\$1,776	\$1,686
Nonmetallic minerals except fuels -----	do.	\$102	\$123	\$110
Manufacturing total -----	do.	\$29,072	\$29,517	\$29,456
Primary metal industries -----	do.	\$4,124	\$3,756	\$3,334
Stone, clay, and glass products -----	do.	\$1,341	\$1,385	\$1,421
Chemicals and allied products -----	do.	\$1,990	\$2,150	\$2,245
Petroleum and coal products -----	do.	\$685	\$692	\$601
Construction -----	do.	\$6,023	\$6,495	\$7,336
Transportation and public utilities -----	do.	\$7,707	\$7,878	\$8,199
Wholesale and retail trade -----	do.	\$16,311	\$17,351	\$18,611
Finance, insurance, real estate -----	do.	\$5,666	\$6,247	\$7,405
Services -----	do.	\$23,808	\$26,425	\$28,813
Government and government enterprises -----	do.	\$13,952	\$14,768	\$15,207
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do.	39,546	43,566	53,442
Value of nonresidential construction <sup>4</sup> -----	millions	\$2,013.0	\$2,115.4	\$2,145.5
Value of State road contract awards <sup>5</sup> -----	do.	\$941.0	\$1,252.0	\$912.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	2,686	3,025	3,367
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$709.4	\$804.5	\$843.1
Value per capita -----	do.	\$60	\$68	\$71

<sup>p</sup>Preliminary. <sup>r</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

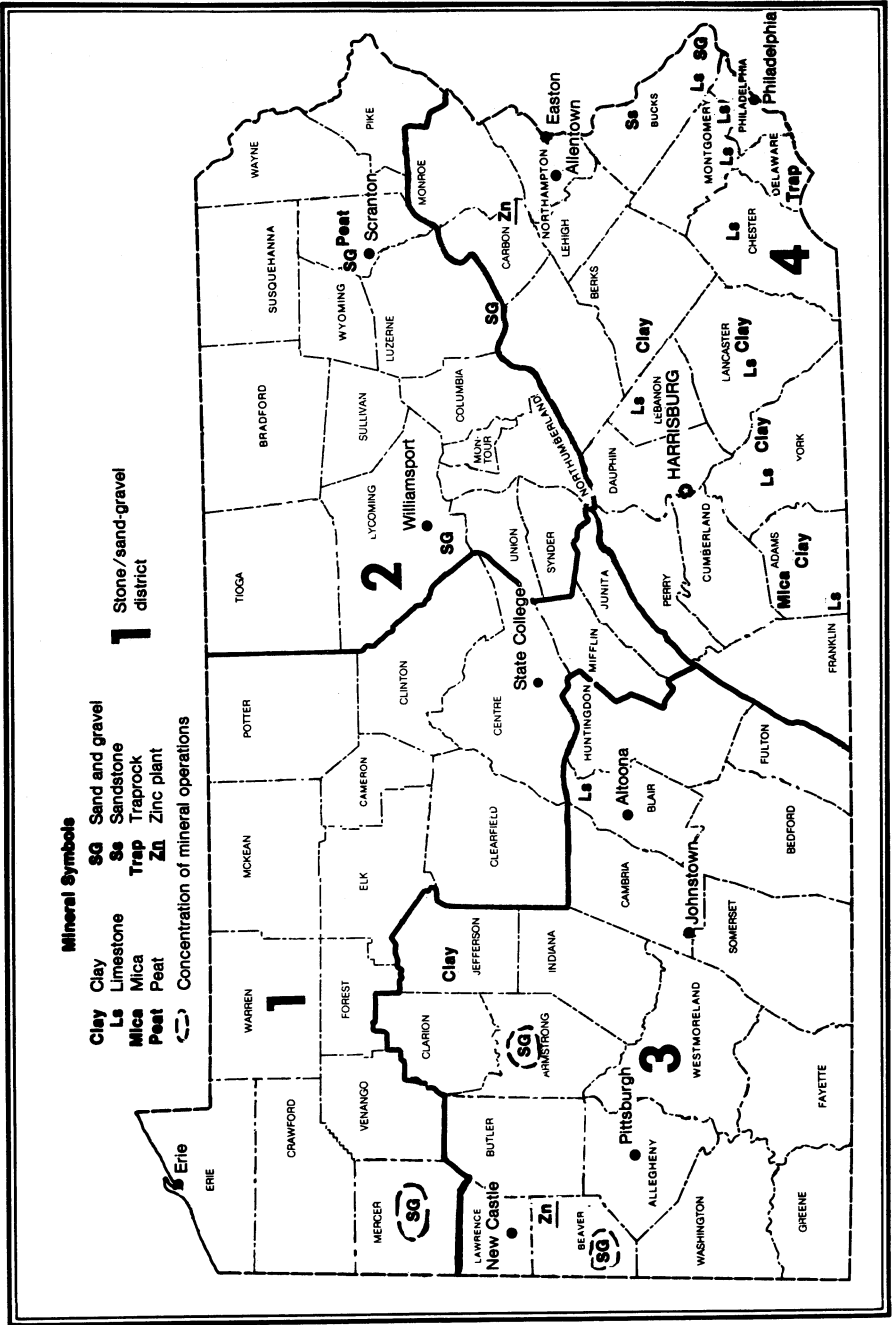


Figure 1.—Principal mineral-producing localities in Pennsylvania.

**Trends and Developments.**—Nonfuel mineral production in Pennsylvania for the past 2 years was revitalized by strong demand from the construction industry. The output of most nonfuel minerals peaked in the late 1970's and began to decline during 1980. By 1982, the value of mineral production had dropped by \$121 million from that of 1979. Production and value began to rebound in 1983 and continued increasing through 1986. The value of nonfuel mining increased \$242 million from 1982 to 1986.

Despite the significant gain in value, output remained below the levels reported in the late 1970's, although increasing since 1982. Higher average production was reported in 1978-79 for crushed stone (6.2 million short tons), sand and gravel (3.3 million tons), and cement (720,000 tons) than in 1985-86.

The State's coal and steel industries reported much greater declines in production than those reported in the late 1970's. Bituminous coal production of 69.5 million short tons in 1986 was about 20 million tons lower than that of 1979. In steel, output dropped 66% from that of 1979. A 5-month strike at the State's leading steelmaker in 1986 affected production, but not as much as the increased international competition, which, since 1980, resulted in plant closings and capacity cutbacks.

The decline in coal and steel directly affected Pennsylvania's lime and limestone industries. Both the steel industry and the coal industry, to a lesser extent, consumed lime and limestone in their operations. Losses also occurred indirectly in production of other nonfuel minerals as employment and earnings declined in the steel and coal industries.

**Legislation and Government Programs.**—The U.S. Department of Transportation proposal to sell the federally owned Consolidated Railroad Corp. (Conrail) directly to private interests was dropped. That action concerned the State's coal, steel, and other mineral producers who depended on rail transportation to move bulk cargoes. Although not finalized at yearend, a public offering of Conrail stock was expected in 1987. Nearly 40% of the company work force and 28% of its railroad system are in Pennsylvania.

The U.S. Bureau of Mines Pittsburgh Research Center continued research programs directed at improving health, safety, and productivity in the mining industries and conserving environmental resources. Mine-scale research was conducted under

controlled conditions at facilities including the Experimental Mine, the Safety Research Coal Mine, the Mine Equipment Test Facility, the Wire Rope Laboratory, and the Lake Lynn Laboratory. In addition, the Bureau funded the Mining and Mineral Resources and Research Institute at Pennsylvania State University (PSU) under Public Law 98-409. PSU received a \$142,000 grant for that program and shared in a \$5 million grant as one of five generic research centers.

The Pennsylvania Bureau of Topographic and Geologic Survey was the primary State agency involved in mineral resource investigations. Previously unknown high-purity silica resources from 30 locations in the eastern part of the State were examined.<sup>3</sup> Articles on selected industrial mineral activities in Pennsylvania, such as use of carbonate building stone from Cumberland County,<sup>4</sup> limestone production in the Allegheny Plateau,<sup>5</sup> underground clay mining for the manufacture of chimney bricks,<sup>6</sup> and an annual mining review<sup>7</sup> were published. Approximately 210 feet of limestone with 90% CaCO<sub>3</sub> and 4% insoluble residue was identified in the Valley and Ridge Province near Union Furnace, PA.<sup>8</sup> A short historical and economic geologic review of the State was published as part of the survey's 150th anniversary.<sup>9</sup>

The Pennsylvania survey also reported that interest remained high in exploration for industrial minerals used primarily as fillers. Investigations were conducted for resources of carbonate, mica, silica, and talc. A previously discovered talc deposit in Lancaster County received a permit from the State Department of Environmental Resources (DER). Limited production at that mine was expected to begin in 1987, with initial sales for use as roofing-grade material.

Government programs involving waste materials, including utilization and recycling research, continued during the year. In each of the past 3 years, Pennsylvania has generated more than 5 million short tons of hazardous waste. The primary metals industry produced about 40% of the waste.

Treatment and disposal of hazardous wastes typically becomes a local issue when a site for a new facility is chosen. The State DER, however, has the authority to issue a Certificate of Public Necessity enabling a proposed facility to be built despite local objections.

The U.S. Bureau of Mines and St. Joe

Minerals Corp., in Monaca, PA, signed a 3-year, \$3.45 million agreement to continue development of flame-reactor technology for recovery of cobalt, lead, nickel, and zinc from dust waste generated in steel manufacturing in electric arc furnaces. Annually, about 500,000 short tons of dust is generated by the domestic steel industry. In 1986, St. Joe operated a prototype plant and expected to market the process in 1987.

The U.S. Department of Energy and East

Stroudsburg University successfully demonstrated the conversion of anthracite waste material into useful energy. Anthracite has been produced in Pennsylvania for more than 150 years, and in excess of 900 million tons of waste or culm has resulted from that production. The culm, which is low-quality anthracite typically laden with rock, was estimated to have the energy equivalent of more than 1 billion barrels of oil.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Most of the nonfuel mineral commodities identified in table 1 are discussed in this section. Commodities processed or manufactured in Pennsylvania included graphite, gypsum, perlite, slag, sulfur, sulfuric acid, and vermiculite.

**Cement.**—Output of portland cement exceeded 6 million short tons for the first time in 7 years. Availability of lower cost imports prevented a price increase despite strong demand from the construction industry. Typically, during periods of strong demand, cement producers are able to invest in plant improvements as profit margins usually increase. However, because of the intense international competition, cement prices in 1986 remained flat. This particularly affected Pennsylvania's cement industry because most of its plants were the wet-process type, which is more energy intensive and, therefore, more costly to operate.

Cement data for Pennsylvania are divided into two districts: eastern Pennsylvania, which is all counties east of the eastern boundaries of Potter, Clinton, Centre, Huntingdon, and Franklin Counties; and western Pennsylvania, which is all other counties in the State. The State's nine eastern plants produced 4.8 million short tons of portland cement, utilizing about 81% of capacity. Pennsylvania's four western plants produced about 1.4 million tons of portland cement, utilizing about 62% of capacity. Pennsylvania ranked third nationally in portland cement production and second in masonry cement.

**Clays.**—Demand for common clay, as used in the manufacture of brick, resulted in the third consecutive year of increased State output. About 72% of the clay mined in Pennsylvania was made into brick. Fire clay production used primarily by the steel industry in refractories dropped by nearly 36,000 short tons or about 45% compared with the 1985 total. Statewide, 14 companies produced common clay; 3 companies produced fire clay; and 1 company produced kaolin. Data for kaolin are proprietary.

Ibstock-Johnson Ltd., a brick manufacturing firm from the United Kingdom, purchased Hanley Brick Inc. of Summerville, Jefferson County. Hanley, in operation for 93 years, has the capacity to produce 50 million brick annually. In 1979, Ibstock-Johnson acquired the Glen-Gery Corp., the State's leading clay producer.

During the year, Glen-Gery increased brickmaking capacity at its Bigler, Berks County, operation with installation of an oxygen-injection system. The firm resumed mining after settlement of a 4-year zoning dispute at an operation near Reading. Glen-Gery agreed to restore mined land to its original condition, protect the ground water, and pay \$10,000 to Lower Heidelberg Township to increase the area it was allowed to mine.

Harbison-Walker Refractories, a division of Dresser Industries Inc., permanently shut down its Mount Union plant. The decline in steelmaking and weak demand for coke-oven products were cited in closing the facility, which had produced silica brick for more than 90 years.

**Table 4.—Pennsylvania: Clays sold or used by producers, by use<sup>1</sup>**  
(Short tons)

Use	1985	1986
Common brick	10,000	28,681
Face brick	772,491	857,013
Firebrick, blocks and shapes	139,204	119,392
Flue linings	44,348	32,823
Mortar and cement, refractory	38,926	30,682
Portland and other cements	93,080	119,904
Tile: Drain, quarry, structural	31,295	31,001
Other <sup>2</sup>	12,873	14,295
Total	1,142,217	1,233,791

<sup>1</sup>Excludes kaolin.

<sup>2</sup>Includes paint, lightweight aggregates, highway surfacing, and structural concrete.

**Lime.**—Pennsylvania ranked third nationally in output, accounting for about 10% of the U.S. total. The trend toward increased lime usage for environmental applications such as sulfur removal from stack gases and mine and plant acid water neu-

tralization continued, while the consumption by the steel industry remained on the decline. Output in 1986 of 1.4 million short tons was slightly lower than that of 1985, but far below the average production in the late 1970's of 2.1 million tons.

**Table 5.—Pennsylvania: Lime sold and used by producers, by use**

Use	1985		1986	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace	545,453	\$29,454	569,221	\$28,847
Steel, electric	194,462	10,495	146,770	7,007
Sewage treatment	143,342	8,807	107,790	6,131
Acid water neutralization (mine and plant)	46,428	2,464	57,691	3,135
Water purification	72,543	4,323	64,514	3,720
Paper and pulp	30,844	1,543	25,779	1,265
Agriculture	W	W	11,639	767
Other <sup>1</sup>	458,907	28,183	433,897	30,362
Total	1,491,979	85,269	1,417,301	81,234

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

<sup>1</sup>Includes alkalis, animal and human food, glass, manganese (1985), mason's lime, oil well drilling (1985), paint, petroleum refining, refractories, sand lime brick, soil stabilization, sugar refining, sulfur removal from stack gases, steel (open-hearth), tanning, wire drawing, other chemical and industrial uses, other metallurgy, other ore concentration, and data indicated by symbol W.

**Mica.**—One company mined a small quantity of mica (sericite) from an open pit near Fairfield, Adams County. The material was processed at a plant in Aspers and marketed to the automotive industry as a filler and extender.

**Peat.**—In 1986, eight companies produced peat; two each in Erie and Lackawanna Counties, three in Luzerne County, and one in Monroe County.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The average price per short ton of sand and gravel in Pennsylvania of \$4.48 (plant

f.o.b.) was the second highest in the Nation. The average U.S. price per ton in 1986 was \$3.11. A similar pattern of higher prices for sand and gravel occurred in States bordering Pennsylvania that produced less than 20 million short tons. In Maryland, with output totaling about 18 million tons, the average price of \$4.78 per ton was highest in the Nation. In New Jersey, with production of 14 million tons, the average price was \$3.84. However, in Ohio, which produced about 37 million tons, the average price was \$3.44 per ton, and in New York, with output of 31 million tons, the price was \$3.33.

In 1986, the U.S. Bureau of Mines began compiling sand and gravel production statistics by districts for some States. Table 7 presents end-use data for sand and gravel in the four Pennsylvania districts that are outlined in figure 1.

Sand and gravel was produced in 37 of Pennsylvania's 67 counties. Bucks, Westmoreland, Mercer, Northampton, and Wyoming were the leading producing counties in order of descending output. Statewide, 107 companies operated 137 pits producing

about 15.4 million tons of sand and gravel. New mining permits were pending with the State DER for 14 sand and gravel operations having a combined capacity of about 500,000 short tons.

Table 6.—Pennsylvania: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	4,100	\$20,679	\$5.04
Plaster and gunite sands -----	249	1,378	5.53
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	473	2,548	5.39
Asphaltic concrete aggregates and other bituminous mixtures -----	2,579	11,993	4.65
Road base and coverings <sup>1</sup> -----	3,975	13,375	4.35
Fill -----	495	1,303	2.63
Snow and ice control -----	278	1,108	3.99
Other <sup>2</sup> -----	248	1,098	4.43
Other unspecified <sup>3</sup> -----	3,987	15,399	3.86
Total <sup>4</sup> or average -----	15,373	68,880	4.48

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes roofing granules.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

Table 7.—Pennsylvania: Construction sand and gravel sold or used by producers in 1986, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	810	2,883	898	4,096	887	5,923	2,227	11,703
Asphaltic concrete aggregates and other bituminous mixtures -----	448	1,777	578	2,461	1,000	6,341	553	1,414
Road base and coverings <sup>2</sup> -----	744	2,244	580	2,295	766	4,539	985	4,297
Fill -----	269	855	84	141	W	W	W	W
Snow and ice control -----	113	357	59	199	W	W	W	W
Other unspecified <sup>3</sup> -----	1,342	3,974	1,329	5,672	1,138	5,975	565	1,736
Total <sup>4</sup> -----	3,725	12,089	3,528	14,863	3,791	22,778	4,330	19,150

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes roofing granules, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Three companies produced industrial sand in Pennsylvania, one each in Allegheny, Carbon, and Huntingdon Counties. Most of the sand was used in glass manufacture.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Pennsylvania ranked third nationally in crushed stone production, accounting for about 6% of the U.S. total. Seven new crushed stone operations with a total annual capacity of about 1 million short tons were reported to have begun work during the year. Most of these operations were in western Pennsylvania and resulted from adjustments to new absorption standards adopted by the State Department of Transportation.

About 70% of the crushed stone produced in Pennsylvania was limestone. Emphasis on and development of clean coal technology (CCT) has expanded in the past few years, coinciding with increased concern and legislation aimed at lowering sulfur dioxide emissions, a component of acid rain. Generally, CCT removes sulfur from coal, with some of the technology requiring as much as 1 ton of limestone for every 3 tons of coal burned. Because of this situation, speculation existed that utilities may combine coal and lime-limestone purchases. If this occurred, coal companies could diversify into the limestone business or develop marketing arrangements with limestone producers to secure limestone sources.<sup>10</sup> In addition, six new cogeneration plants were in various stages of planning and development in the eastern part of the State. An estimated 250,000 to 500,000 tons of carbonate rock was expected to be used at these plants equipped with European-designed fluidized-bed systems.

*Dimension.*—Sandstone, slate, and diabase were quarried for dimension stone products. Two new flagstone (bluestone) quarries received permits in the eastern part of the State. These operations marketed building stone to Philadelphia markets.

## METALS

Metals discussed in this section were processed from materials received from both foreign and domestic sources. Production and value data for these commodities, which are not included in table 1, are given if available.

**Beryllium.**—The Cabot Wrought Products Div. of Cabot Corp. sold its Reading, PA, facilities, among others, to NGK Insulators Ltd. of Japan. The operation was renamed NGK Metals Corp. and continued producing beryllium-copper and other beryllium alloys.

**Iron and Steel.**—Shipments of steel and pig iron dropped substantially, primarily because of a 5-month labor strike at the State's leading steelmaker. USX Corp., formerly United States Steel Corp., was unable to negotiate a new labor agreement, which would have prevented a work stoppage that began August 1 and continued through yearend. USX also finalized a \$3.7 billion agreement to purchase Texas Oil & Gas Corp. that lessened its steel operations to 33% of its total business.

During labor contract negotiations, USX offered to guarantee installation of a continuous caster at its Edgar Thomson plant in

Braddock and to modernize the Irvin plant in Dravosburg if a 4-year agreement was accepted.<sup>11</sup> None of USX's steel plants in Pennsylvania was equipped with continuous casters as of yearend; nationwide, more than one-half of the raw steel produced was continuously cast.

Also during the year, USX idled its structural steel mill in Homestead, ending all production at that operation. The indefinite shutdown removed 531,000 short tons of annual capacity from the market and reduced to two the number of large (52-inch) structural steel mills operating in the United States. The Homestead plant had employed 2,400 workers in 1984.

Steelmakers, other than USX, reached new labor contracts that lowered wages and benefits in return for profit-sharing plans. Despite a contract that reduced labor costs, LTV Corp. filed for chapter 11 protection under the Federal Bankruptcy Code. Although LTV had previously closed its Pittsburgh and Alliquippa Works in Pennsylvania, the filing adversely affected another segment of the State's mining industry. Under chapter 11 protection, LTV was able to withdraw from high-priced, long-term raw materials purchase contracts. One of those contracts for 1.5 million tons of coal per year was with a coal producer in Washington County, which subsequently closed its mine.

Also permanently closed in 1986 was Wheeling-Pittsburgh Corp.'s (W-P) blast and basic oxygen furnaces in Monessen. As a result of that closure, all of W-P's raw-steel-producing operations in Pennsylvania were shut down. W-P, in chapter 11 since 1985, determined it could not afford to upgrade the operation with electric arc furnaces, thus jeopardizing operation of its rail mill at Monessen. The rail mill, one of three in the United States, was operated sporadically during the second half of the year. The market for rails had diminished from 1.2 million tons in the early 1980's to 800,000 in 1986, with the Monessen mill producing 350,000 tons, or only about one-third the mill's capacity.

Bethlehem Steel Corp. operated three of its five raw-steel-producing facilities in Pennsylvania at Bethlehem, Johnstown, and Steelton. During the year, layoffs and production cutbacks occurred at all three operations as the firm reported a loss for the fifth consecutive year. Because of the tenuous operating conditions at W-P's rail mill in Monessen, Bethlehem expressed interest in purchasing or supplying that oper-



ation with semifinished steel.

Bethlehem also announced intentions to sell certain limestone operations, including quarries in Adams and Lebanon Counties. Production from those quarries was also used in lime manufacture. Output from those operations ranked Bethlehem as the leading lime and third leading crushed stone producer in the State.

**Ferroalloys.**—Production remained about the same for the third consecutive year, indicating a stabilizing of the supply-demand situation for Pennsylvania.

Conditions in the industry nationwide continued to decline as shipments by producers dropped 9% compared with those of 1985. Continued weak demand from the steel industry, a major consuming industry, and competition from imports combined to keep domestic shipments below 1 million short tons for the second year in a row.

**Titanium.**—A. Johnson Metals Corp. operated 1 of 11 domestic titanium metal ingot plants at Lionville. Plant capacity was 1,500 short tons of commercially pure ingot and slab. ALTA Group continued in its second year of production of high-purity titanium used in advanced materials applications such as prosthetics at its plant in Evans City.

**Zinc.**—St. Joe Resources operated one of four primary zinc smelters in the United

States at Monaca, primarily using concentrates from the firm's zinc mines in New York. The New Jersey Zinc Co. Inc. (NJZI) produced zinc oxide at its plant in Palmerton. Horsehead Resources Development Co., operators of wash kiln facilities at NJZI's Palmerton plant, and St. Joe were using and developing technology to recover salable products from electric arc furnace dust, a waste material from steelmaking.

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<sup>2</sup>Economic geologist, Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, PA.

<sup>3</sup>Berkheiser, S. W., Jr. High-Purity Silica Occurrences in Pennsylvania. PA Geol. Surv. Miner. Resour. Rep. 88, 1986, 67 pp.

<sup>4</sup>Pennsylvania Geologic Survey. Building Stones From Cumberland County. PA Geol., v. 17, No. 1, 1986, pp. 10-12.

<sup>5</sup>———. Limestone Production in Pennsylvania's Allegheny Plateau—Allegheny Mineral Corp. PA Geol., v. 17, No. 2, 1986, pp. 10-13.

<sup>6</sup>———. Continental Clay Co., A Part of Pennsylvania's Mineral Heritage Since 1896. PA Geol., v. 17, No. 3, 1986, pp. 8-11.

<sup>7</sup>Berkheiser, S. W., Jr. Pennsylvania. Annual Review, Exploration 1986. Min. Eng. (Littleton, CO), v. 39, No. 5, 1987, pp. 339-340.

<sup>8</sup>Berkheiser, S. W., Jr., and J. Cullen-Lollis. Stop 1, Union Furnace Section—Stratigraphy and Sedimentology. 51st Annu. Field Conf. PA Geol. Guidebook, 1986, pp. 111-119.

<sup>9</sup>Berkheiser, S. W., Jr. Union Furnace Ordovician Carbonates: Past, Present, and Future. 51st Annu. Field Conf. PA Geol. Guidebook, 1986, pp. 7-11.

<sup>10</sup>Malhotra, R. Business Strategies for Adapting to Changing Markets. Coal Min., v. 24, No. 1, Jan. 1987, pp. 34-36.

<sup>11</sup>Larue, G. USX, USW Talks Recess; Stoppage Tops '89 Record. Am. Met. Mark., v. 94, No. 230, Nov. 25, 1986, p. 2.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Cement:</b>			
Coplay Cement Co. -----	Drawer 32 Nazareth, PA 18064	Plant and quarries.	Lehigh and Northamp- ton.
General Portland Inc. -----	5160 Main St. Whitehall, PA 18052	Plant -----	Lehigh.
Hercules Cement Co. -----	Center St. Stockertown, PA 18083	Plant and quarry.	Northampton.
Lone Star Industries Inc. -----	Box 90765 Houston, TX 77290	Plant -----	Do.
<b>Clays:</b>			
L. D. Baumgardner Coal Co. Inc. -----	Box 104, R.D. 3 Phillipsburg, PA 16866	Pit -----	Clearfield.
Glen-Gery Corp. -----	Box 1542 Reading, PA 19603	Pits and plant	Adams, Berks, York.
Medusa Corp. -----	Box 5668 Cleveland, OH 44101	Pit -----	Lawrence.
<b>Lime:</b>			
Bethlehem Steel Corp. <sup>1</sup> -----	Martin Tower Bethlehem, PA 18016	Plants and quarries.	Adams and Lebanon.
Mercer Lime & Stone Co. -----	525 William Penn Pl. Pittsburgh, PA 15219	Plant -----	Butler.
Warner Co. -----	Yellow Springs Rd. Devault, PA 19432	Plant, mine, quarries.	Centre and Chester.
<b>Peat:</b>			
Gouldsboro Wayne Peat Co. -----	Box 68 Gouldsboro, PA 18424	Bog -----	Lackawanna.
Lake Benton Peat Moss -----	622 South Blakely St. Dunmore, PA 18512	Bog -----	Do.

See footnote at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Davison Sand & Gravel Co -----	Third Ave. and Fourth St. New Kensington, PA 15068	Dredge and pits.	Armstrong and Westmoreland.
Dravo Corp -----	4800 Grand Ave. Pittsburgh, PA 15222	Dredge, pit, plant.	Allegheny and Beaver.
Glacial Sand & Gravel Co -----	Box 1022 Kittanning, PA 16201	-----do-----	Armstrong.
Stabler Co. Inc. <sup>1</sup> -----	Box 3188 Wescoville, PA 18106	Pits and plants.	Bradford and Northampton.
Warner Co -----	699 Bristol Pike Morrisville, PA 19067	Pit and plant	Bucks.
Wyoming Sand & Stone Co -----	R.D. 1 Falls, PA 18615	-----do-----	Wyoming.
<b>Industrial:</b>			
McCraday Inc. -----	Box 11566 Pittsburgh, PA 15238	Quarries and plant.	Allegheny.
U.S. Silica Co -----	Box 187 Berkeley Springs, WV 25411	-----do-----	Huntingdon.
<b>Stone:</b>			
<b>Crushed:</b>			
The General Crushed Stone Co., a subsidiary of Koppers Co. Inc.	Box 231 Easton, PA 18042	-----do-----	Berks, Bucks, Chester, Clinton, Columbia, Dauphin, Delaware, Lancaster, Montour, Tioga, York.
New Enterprise Stone & Lime Co. Inc.	R.D. 3 New Enterprise, PA 16664	-----do-----	Adams, Bedford, Blair, Cumberland, Franklin, Huntingdon, Lancaster, Somerset.
<b>Dimension:</b>			
A. Dally & Sons Inc. -----	Railroad Ave., Box 27 Pen Argyl, PA 18072	Quarries and mills.	Northampton.
Delaware Quarries -----	Route 32 Lumberville, PA 18933	Quarry -----	Bucks.
Pennsylvania Granite Corp -----	Box 510 St. Peters, PA 19470	-----do-----	Chester.

<sup>1</sup>Also stone.



# The Mineral Industry of Puerto Rico, Caribbean and Pacific Island Possessions, and Trust Territory of the Pacific Islands

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

By Doss H. White, Jr.,<sup>1</sup> and Ivette E. Torres<sup>2</sup>

## PUERTO RICO

The mineral industry in Puerto Rico produced \$124 million worth of mineral commodities in 1986. Output and value increased for all commodities, excluding clays and crushed stone (estimated).

Table 1.—Nonfuel mineral production in Puerto Rico<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) — thousand short tons ..	997	\$87,568	962	\$72,602	1,132	\$93,288
Clays .....	128	266	118	264	111	223
Lime .....	35	4,531	23	3,249	24	3,291
Salt .....	—	—	<sup>†</sup> 35	<sup>†</sup> 735	40	880
Sand and gravel (industrial) .....	43	W	—	—	31	624
Stone:						
Crushed .....	<sup>¶</sup> 5,813	<sup>¶</sup> 27,675	5,493	25,799	<sup>¶</sup> 5,400	<sup>¶</sup> 26,000
Dimension .....	W	W	W	W	—	—
<b>Total<sup>2</sup> .....</b>	<b>XX</b>	<b><sup>†</sup>120,040</b>	<b>XX</b>	<b><sup>†</sup>102,649</b>	<b>XX</b>	<b>124,306</b>

<sup>¶</sup>Estimated. <sup>†</sup>Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." XX Not applicable.

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

<sup>2</sup>Total does not include value of data withheld.

**Table 2.—Nonfuel minerals produced in Puerto Rico in 1985, by district<sup>1</sup>**

District	Minerals produced in order of value
Aguadilla -----	Stone (crushed).
Arecibo -----	Do.
Guayama -----	Do.
Humacao -----	Do.
Mayagüez -----	Stone (crushed), salt.
Ponce -----	Cement, stone (crushed), lime, clays.
San Juan -----	Cement, stone (crushed), stone (dimension).

<sup>1</sup>No production of nonfuel mineral commodities was reported for districts not listed.

**Table 3.—Indicators of Puerto Rico business activity**

	1984 <sup>†</sup>	1985	1986 <sup>‡</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands ..	3,269	3,282	3,274
Total civilian labor force <sup>1</sup> -----	do ..	958	969	998
Unemployment <sup>1</sup> -----	percent ..	20.7	21.8	18.9
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands ..	0.7	0.7	0.7
Manufacturing total -----	do ..	150.1	147.5	149.2
Stone, clay, and glass products -----	do ..	3.8	3.9	4.2
Chemicals and allied products -----	do ..	16.4	17.2	17.7
Construction -----	do ..	27.5	26.3	28.1
Transportation and public utilities -----	do ..	15.5	15.7	15.8
Wholesale and retail trade -----	do ..	116.4	120.8	125.1
Finance, insurance, real estate -----	do ..	29.3	31.1	32.6
Services -----	do ..	91.3	95.1	97.8
Government and government enterprises -----	do ..	253.2	255.4	266.4
Total <sup>2</sup> -----	do ..	684.1	692.5	715.7
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		38.7	38.5	39.0
Total average hourly earnings, production workers -----		\$5.0	\$5.2	\$5.3
<b>Construction activity:</b>				
Shipments of portland cement (by destination) -----	thousand short tons ..	1,000	962	1,182
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions ..	\$120.0	\$102.6	\$124.3
Value per capita -----		\$37	\$31	\$39

<sup>‡</sup>Preliminary. <sup>†</sup>Revised.

<sup>1</sup>Branch of Local Area Unemployment, Bureau of Labor Statistics.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

Sources: U.S. Department of Commerce, U.S. Department of Labor, and U.S. Bureau of Mines.

**Trends and Developments.**—Puerto Rico's mineral output was used primarily by the construction industry, and the past two decades have seen a drop in construction activity and subsequent mineral demand throughout the island. Employment in the construction industry, one indicator of the industry's health, slumped from 40,200 in 1980 to 28,100 in 1986.<sup>3</sup> The industry was slow to rebound from the recession of the early 1980's. However, construction activity, flat during the first half of 1986 (23,100 in January), picked up sharply during the last half of the year, fueled by a decline in interest rates. At yearend, construction employment had climbed to 31,700.

Total construction permits granted in the July-November period (first 5 months of fiscal year (FY) 1987) were 27.2% higher than for the same period in 1985. In terms

of value, the increase was 30.7%, averaging almost \$47 million per month.

Transportation and public works were also major users of construction minerals. The Department of Transportation and Public Works FY 1986-87 budget of \$150 million was a 35% increase over FY 1985-86. At yearend, work was under way on port improvements, roads, bridges, the Agua Guagua project, and several maintenance projects.<sup>4</sup>

The Puerto Rico Aqueduct and Sewer Authority budgeted \$171 million for construction and continued work on plans to construct five regional sewage treatment plants costing between \$40 million and \$90 million each. A continuing moratorium by the U.S. Environmental Protection Agency on home sewer hookups stalled or canceled some home building projects.

A building endorsement system, under which a single project could require the approval of 23 Commonwealth agencies, was delaying numerous projects. A report by construction trade organizations on methods to streamline the endorsement system will be submitted to the Governor in 1987.

Opposition from environmental groups and island politics discouraged efforts by Kennecott Copper Corp. and AMAX Inc. to develop copper deposits underlying several thousand acres in the Lares Utuado-Adjuntas area, and the property was sold in 1986.

#### REVIEW BY NONFUEL MINERAL COMMODITIES

**Industrial Minerals.**—Puerto Rico's industrial minerals output increased 21% in value over the value reported in 1985. The island's mineral industry produced portland cement, clays, lime, salt, industrial sand, and crushed and dimension stone. Synthetic graphite shapes and byproduct sulfur, whose value is not included in table 1, comprised the remainder of the nonmetallic segment of the island's mineral industry.

**Cement.**—Puerto Rican Cement Co. Inc., an affiliate of the Empresas Diaz corporate group, operated a cement plant at Dorado near Ponce, and San Juan Cement Co. Inc. operated a cement plant west of San Juan. The two cement producers were facing, and fighting, the specter of cement imports, primarily from Barbados and Honduras. Since 1983, imports tripled from 554,000 pounds to 1.7 million pounds in 1986. At yearend, imports accounted for 5% of the island's bulk cement sales and 13% of the bagged cement sales. Imported cement sales cost the two Puerto Rican cement companies approximately \$4 million in 1986. At yearend, the two companies were contemplating filing dumping charges with the International Trade Commission of the U.S. Department of Commerce.<sup>5</sup>

**Table 4.—Puerto Rico: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	2	2
Production	964,214	1,129,724
Shipments from mills:		
Quantity	962,225	1,132,087
Value	\$72,601,874	\$93,287,887
Stocks at mills, Dec. 31	35,265	33,664

**Clays.**—Several companies mined clay as raw material for brick and tile manufac-

ture; the value of this material was not included in the island's mineral value. The two cement companies mined clay for use in clinker manufacture, and the value of this clay comprises the clay value noted in table 1.

**Graphite.**—A Union Carbide Corp. plant, at Yabucoa, manufactured synthetic graphite electrodes used in electric steel furnaces from petroleum coke obtained from Union Carbide's plant at Penuelas.

**Lime.**—Puerto Rican Cement produced chemical-grade lime at its plant near Ponce. Primary markets were in Puerto Rico and the Virgin Islands, and principal uses were for water purification and construction. Lime was also used in bauxite refining, and the closing of the St. Croix aluminum plant had a negative affect on lime sales.

**Salt.**—Cabo Rojo Enterprises operated an evaporative seawater saltworks on Puerto Rico's southwest coast, and a second company produced evaporative salt near La Parquera. Principal sales were to the pharmaceutical and petrochemical producers, tuna packers, sugar mills, and curing and tanning plants.

**Sand and Gravel (Industrial).**—Several stone crushing firms produced a sand-size material used by the construction industry, and inland dune sand was reported to have been mined by some companies.

Owens-Illinois de Puerto Rico used an industrial sand mined under contract for bottle manufacture at a plant near Vega Alta. The company also purchased ground glass to supplement the industrial sand production.

In 1986, the company purchased approximately 250 tons of ground glass per month, approximately 30% of the plant's raw material requirements. The company's goal was to use 100% ground glass for plant feed and to phase out the industrial sand operation. Melting ground glass used less energy and extended furnace life, which allowed the company to produce bottles at a lower cost.<sup>6</sup>

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Records of the U.S. Department of Labor, Mine Safety and Health Administration (MSHA) indicate that crushed stone was produced at 48 operations in all 7 of the island's districts.

MSHA records also noted that during 1986, 3 dimension stone operations were in business, employing 30 workers.

## CARIBBEAN ISLAND POSSESSIONS

The U.S. Virgin Islands was the only U.S. Territory in the Caribbean reporting mineral production.

Mineral producers were active on both St. Croix and St. Thomas. Industrial mineral production consisted of construction sand and traprock for aggregate.

Devcon International Corp. operated one quarry on St. Thomas and one on St. Croix. On St. Thomas, the Brookman quarry, operated by Control Concrete Products Inc., a subsidiary of Devcon, produced both crushed stone and manufactured sand. The company imported approximately 30% of the island's annual sand requirements from Barbuda, an island about 40 miles north of Antigua. Approximately 15% of the stone consumed in St. Thomas was imported by Turnbull, Malone, and Turnbull (TMT). TMT also imported a limited tonnage of sand.

Mark 21, a Devcon subsidiary, operated a cement storage facility on St. Thomas. The company imported cement from Colombia and Venezuela.

On St. Croix, Caribbean Materials Supply Co. Inc., a Devcon subsidiary, operated the Springfield quarry near the village of Groveplace. Both crushed stone and manufactured sand were produced. The stone was used locally and exported to St. John, St. Barthelemy, St. Martin, Tortola, and Virgin Gorda. Mark 21 imported sand from Barbuda. St. Croix Stone and Sand Inc. operated the Robes Hill Quarry on St. Croix.

At yearend, Martin Marietta Corp., Bethesda, MD, was seeking a buyer for its St. Croix alumina plant, which was closed in 1985. The company was negotiating with a Nebraska businessman and an Australian firm.

## PACIFIC ISLAND POSSESSIONS

American Samoa and Guam were the only U.S. Pacific Island possessions reporting mineral production—volcanic rock and coral crushed for aggregate applications. Cement was imported and sand was pro-

duced locally for concrete usage. It was possible that some of the other island possessions had intermittent sand and stone quarries.

## TRUST TERRITORY OF THE PACIFIC ISLANDS

In recent years, mining in the islands that comprise the Trust Territory of the Pacific Islands has been restricted to the production of crushed stone and sand. However, in 1986, several companies funded active exploration programs for precious metals in several areas of Micronesia.

In future Minerals Yearbook chapters, mineral activity in the portions of the Trust Territory that have become independent

entities will be discussed in volume III.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Program specialist, Minerals Information, Washington, DC.

<sup>3</sup>Caribbean Business. Construction/Real Estate. Feb. 26, 1987.

<sup>4</sup>\_\_\_\_\_. Public Construction Projects Will Spur Industry in 1987. Feb. 11, 1987.

<sup>5</sup>\_\_\_\_\_. The Great Caribbean Cement War. Mar. 5, 1987.

<sup>6</sup>\_\_\_\_\_. Glass Recycling Provides Work for a Lot of People. Aug. 13, 1986.

# The Mineral Industry of Rhode Island

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

By Donald K. Harrison<sup>1</sup>

The value of nonfuel mineral production in 1986 was \$14.2 million. This all-time high value resulted from the continuing building boom in the Northeast, which began after the last recession, coupled with higher unit value prices. Sand and gravel and crushed stone were the only two mineral commodities produced. Although there were only

about 200 workers engaged in mining in 1986, nearly 17,200 others worked in mineral-dependent construction and another 7,100 were employed in manufacturing stone, clay, glass, and primary metal products. The State ranked 49th in total mineral value.

Table 1.—Nonfuel mineral production in Rhode Island<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel:						
Construction --- thousand short tons...	1,483	\$5,282	1,200	\$4,600	2,269	\$8,252
Industrial -----do.-----	W	W	W	W	22	143
Stone (crushed) -----do.-----	<sup>e</sup> 1,000	<sup>e</sup> 5,800	<sup>2</sup> 1,135	<sup>2</sup> 7,016	<sup>e</sup> 21,000	<sup>e</sup> 25,700
Combined value of other industrial minerals and values indicated by symbol W-----	XX	<sup>1</sup> 466	XX	576	XX	101
Total -----	XX	<sup>1</sup> 11,548	XX	12,192	XX	14,196

<sup>e</sup>Estimated. <sup>1</sup>Revised. W Withheld to avoid disclosing company proprietary data, value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes certain stones; value included with "Combined value" figure.



**Table 2.—Nonfuel minerals produced in Rhode Island in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Newport -----	Stone (crushed).
Providence -----	Stone (crushed), sand (industrial).
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for regions not listed.

<sup>2</sup>Data not available by counties for minerals listed.

**Table 3.—Indicators of Rhode Island business activity**

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	960	967	975
Total civilian labor force -----	do	490	500	510
Unemployment -----	percent	5.3	4.9	4.0
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	0.2	0.1	0.2
Manufacturing total -----	do	121.7	119.2	119.4
Primary metal industries -----	do	6.2	5.7	5.4
Stone, clay, and glass products -----	do	1.9	1.7	1.7
Chemicals and allied products -----	do	3.1	3.1	3.1
Construction -----	do	13.3	15.2	17.0
Transportation and public utilities -----	do	13.5	13.9	14.7
Wholesale and retail trade -----	do	88.6	94.6	99.0
Finance, insurance, real estate -----	do	22.7	23.6	24.9
Services -----	do	99.0	105.0	109.1
Government and government enterprises -----	do	57.4	57.7	58.0
<b>Total<sup>1</sup></b> -----	do	416.4	429.2	442.1
<b>Personal income:</b>				
Total -----	millions	\$12,475	\$13,208	\$14,213
Per capita -----	do	\$12,993	\$13,682	\$14,579
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----	do	40.9	40.2	40.5
Total average hourly earnings, production workers -----	do	\$7.3	\$7.6	\$7.9
<b>Earnings by industry:<sup>2</sup></b>				
Farm income -----	millions	\$35	\$50	\$48
Nonfarm -----	do	\$8,427	\$9,079	\$9,877
Mining total -----	do	\$21	\$29	\$30
Nonmetallic minerals except fuels -----	do	\$2	\$3	\$3
Oil and gas extraction -----	do	\$18	\$26	\$26
Manufacturing total -----	do	\$2,524	\$2,542	\$2,659
Primary metal industries -----	do	\$202	\$150	\$147
Stone, clay, and glass products -----	do	\$51	\$51	\$55
Chemicals and allied products -----	do	\$85	\$86	\$90
Petroleum and coal products -----	do	\$5	\$8	\$7
Construction -----	do	\$423	\$490	\$577
Transportation and public utilities -----	do	\$367	\$388	\$422
Wholesale and retail trade -----	do	\$1,291	\$1,440	\$1,586
Finance, insurance, real estate -----	do	\$494	\$542	\$641
Services -----	do	\$1,908	\$2,119	\$2,351
Government and government enterprises -----	do	\$1,356	\$1,457	\$1,528
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>3</sup> -----	do	4,236	5,408	7,274
Value of nonresidential construction <sup>3</sup> -----	millions	\$131.1	\$154.2	\$165.0
Value of State road contract awards -----	do	\$152.2	\$128.5	\$151.5
Shipments of portland and masonry cement to and within the State <sup>4</sup> -----	thousand short tons	202	169	205
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$11.5	\$12.2	\$14.2
Value per capita -----	do	\$12	\$13	\$15

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Data may not add to totals shown because of independent rounding.

<sup>2</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>3</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>4</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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 State Geologist's Office, with funded support from the U.S. Geological Survey and the Connecticut Geological and Natural History Survey, began a surficial and bedrock mapping program. The mapping primarily focused on producing a revised State bedrock map consistent with Connecticut and Massachusetts maps. The State Geologist's Office also continued to be involved with the State Department of Environmental Management in areas of aquifer protection and landfill siting. In addition, localities with potentially high radon levels were identified for the State Department of Health as part of the U.S. Environmental Protection Agency-funded radon survey. A multiyear joint program with the Connecticut Survey and funded by the U.S. Minerals Management Service continued with seismic surveying of selected offshore areas that have potential for exploitation of nonfuel mineral resources.

The Rhode Island Office of State Planning, a division of the Department of Administration, continued revising its State Land Use Policies and Plan adopted in 1975. The primary purpose of the revision was to develop and update the existing land use plan and extend the planning horizon from 1990 to the year 2010. Topics to be addressed included air quality, water resources, acid

rain, energy resources, and land surface features (topography, geology, minerals, earthquakes, and sea-level rise). Technical papers published during 1986 included ones on water resources, coastal resources, and transportation and land use.

In January, a public information booklet entitled "Siting High-Level Nuclear Waste Repositories: A Progress Report for Rhode Island" was published by the Office of State Planning. The report was the result of the Nuclear Waste Fund established by the Nuclear Waste Policy Act of 1982, which provided financial support to Rhode Island and 16 other States to participate in the U.S. Department of Energy's (DOE) high-level radioactive waste repository siting program. These 17 States were selected by virtue of their extensive granite deposits, which DOE considered a suitable medium for housing the repository.

The New England-New York Water Council of the New England Governor's Conference prepared an "Action Plan for Water Management" in the seven-State region, which included Rhode Island. Policies and recommendations were designed to achieve regional objectives in toxic substances, acid rain, and ground water resources. The plan was adopted by all the States.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Output and value of construction sand and gravel, the State's leading mineral commodity, increased substantially compared with 1985 estimates. It was produced by 14 companies at 16 pits in 3 counties. Leading counties in order of output were Kent, Providence, and Washington. The product was used principally for concrete aggregate, asphaltic concrete aggregates, road base and coverings, and fill.

**Table 4.—Rhode Island: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	569	\$2,262	\$3.98
Asphaltic concrete aggregates and other bituminous mixtures -----	W	W	5.35
Road base and coverings -----	W	W	1.08
Fill -----	52	66	1.27
Railroad ballast -----	11	47	4.27
Other unspecified <sup>1</sup> -----	1,637	5,876	3.59
Total or average -----	2,269	28,252	3.64

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

<sup>1</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Holliston Sand Co. was the only industrial sand producer in 1986. The company operated a pit in Slatersville, Providence County.

**Stone (Crushed).**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Estimated crushed stone produced totaled 1 million short tons valued at \$5.7 million, a 12% decrease in quantity and a 19% decrease in value. In 1985, four companies operated quarries in Providence County and one operated in Newport County. Both granite and limestone were produced.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

**Table 5.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Sand and gravel:</b>			
A. Cardi Construction Co. Inc --	451 Arnold Rd. Coventry, RI 02816	Pits and plant ---	Kent.
Holliston Sand Co. <sup>1</sup> -----	Box 393 Slatersville, RI 02876	Pit and plant ---	Providence.
River Sand & Gravel Co. Inc ---	101 Ferris St. Pawtucket, RI 02861	Pit -----	Kent.
South County Sand & Gravel Co. -	North Rd. Peace Dale, RI 02878	Pit and plant ---	Washington.
TASCA Sand & Gravel Co.-----	Box 123 R.F.D. 4 Smithfield, RI 02917	Pit -----	Providence.
<b>Stone (1985):</b>			
Forté Bros. Inc -----	14 Whipple St. Berkley, RI 02864	Quarry -----	Do.
J. H. Lynch & Sons Inc. <sup>2</sup> -----	825 Mendon Rd. Cumberland, RI 02864	---do -----	Do.
Tilcon Inc -----	875 Phoenix Ave. Cranston, RI 02920	---do -----	Do.

<sup>1</sup>Also industrial sand.

<sup>2</sup>Also sand and gravel.

# The Mineral Industry of South Carolina

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey, State Division of Research and Statistical Services, for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,<sup>1</sup> and Arthur H. Maybin<sup>2</sup>

In 1986, the value of South Carolina's nonfuel mineral production, comprising two metallic and nine industrial minerals, totaled \$295.9 million, a new State record. A significant part of the State's mineral output was used by the construction industry; depressed fuel prices and low interest rates played a major role in creating a healthy climate for construction. The strong showing in both residential and commercial construction resulted in an increased demand for those mineral commodities that

were the basic raw materials used by construction firms: cement, clays, sand and gravel, and stone. These four accounted for 87% of the State's mineral value.

South Carolina continued to rank 19th nationally in the production of industrial minerals and 27th in total mineral production. During 1986, two companies announced plans to open the State's second and third gold mining operations; the State's only fuller's earth operation closed.

Table 1.—Nonfuel mineral production in South Carolina<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement (portland) — thousand short tons...	2,319	\$103,891	2,207	\$104,705	2,306	\$109,529
Clays <sup>2</sup> -----do-----	1,834	36,809	1,896	37,695	1,986	37,980
Gem stones-----do-----	NA	<sup>e</sup> 10	NA	<sup>e</sup> 10	NA	10
Manganiferous ore-----short tons...	20,404	W	19,882	W	14,320	W
Peat-----do-----	5	W	W	173	W	W
Sand and gravel:						
Construction-----do-----	5,845	17,097	<sup>e</sup> 4,900	<sup>e</sup> 14,000	7,200	19,783
Industrial-----do-----	882	14,889	794	14,092	800	14,081
Stone:						
Crushed-----do-----	<sup>e</sup> 17,900	<sup>e</sup> 72,500	17,079	72,520	<sup>e</sup> 18,200	<sup>e</sup> 76,700
Dimension-----do-----	<sup>r</sup> 8	<sup>r</sup> 537	8	541	<sup>e</sup> 8	<sup>e</sup> 533
Combined value of cement (masonry), clays (fuller's earth), gold (1985-86), mica (scrap), silver (1985-86), vermiculite, and values indicated by symbol W-----	XX	29,562	XX	32,193	XX	37,273
Total-----	XX	<sup>r</sup> 275,295	XX	275,929	XX	295,889

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fuller's earth; value included with "Combined value" figure.

Table 2.—Nonfuel minerals produced in South Carolina in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Aiken	Clays.
Anderson	Stone (crushed).
Berkeley	Do.
Calhoun	Clays.
Cherokee	Stone (crushed), sand (industrial), manganese, clays.
Chesterfield	Stone (crushed), clays.
Colleton	Peat.
Dorchester	Cement, stone (crushed), clays.
Edgefield	Clays.
Fairfield	Stone (crushed), clays, stone (dimension).
Georgetown	Stone (crushed).
Greenville	Do.
Greenwood	Stone (crushed), clays.
Horry	Do.
Kershaw	Sand (industrial), stone (dimension), clays.
Lancaster	Gold, mica (scrap), stone (dimension), stone (crushed), silver.
Laurens	Vermiculite, stone (crushed).
Lexington	Sand (industrial), stone (crushed), clays.
Marion	Clays.
Marlboro	Do.
Oconee	Stone (crushed).
Orangeburg	Cement, stone (crushed), clays.
Pickens	Stone (crushed).
Richland	Stone (crushed), clays.
Saluda	Clays, manganese.
Spartanburg	Stone (crushed).
Sumter	Clays.
York	Stone (crushed), clays.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of South Carolina business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>	
Employment and labor force, annual average:				
Population	thousands	3,296	3,335	3,377
Total civilian labor force	do.	1,481	1,562	1,602
Unemployment	percent	7.1	6.8	6.2
Employment (nonagricultural):				
Mining total	thousands	1.8	1.7	1.6
Manufacturing total	do.	377.6	365.4	364.0
Primary metal industries	do.	7.5	7.9	7.8
Stone, clay, and glass products	do.	10.7	10.7	10.9
Chemicals and allied products	do.	32.8	32.7	32.4
Petroleum and coal products <sup>1</sup>	do.	.4	.4	.4
Construction	do.	80.8	83.8	88.1
Transportation and public utilities	do.	55.3	56.0	56.1
Wholesale and retail trade	do.	261.2	277.4	291.8
Finance, insurance, real estate	do.	54.4	57.2	61.0
Services	do.	194.2	209.9	222.6
Government and government enterprises	do.	237.3	244.8	253.3
Total <sup>2</sup>	do.	1,262.5	1,296.2	1,338.4
Personal income:				
Total	millions	\$33,528	\$35,842	\$38,153
Per capita	do.	\$10,171	\$10,749	\$11,299
Hours and earnings:				
Total average weekly hours, production workers	do.	40.8	40.4	41.4
Total average hourly earnings, production workers	do.	\$7.3	\$7.6	\$7.9
Earnings by industry: <sup>3</sup>				
Farm income	millions	\$335	\$243	\$176
Nonfarm	do.	\$24,768	\$26,399	\$28,233
Mining total	do.	\$71	\$91	\$90
Manufacturing total	do.	\$7,581	\$7,705	\$8,052
Primary metal industries	do.	\$217	\$230	\$240
Stone, clay, and glass products	do.	\$259	\$264	\$277
Chemicals and allied products	do.	\$1,010	\$1,074	\$1,102
Petroleum and coal products	do.	\$15	\$13	\$15
Construction	do.	\$1,771	\$1,866	\$2,047
Transportation and public utilities	do.	\$1,615	\$1,660	\$1,695
Wholesale and retail trade	do.	\$3,632	\$3,953	\$4,253
Finance, insurance, real estate	do.	\$1,064	\$1,176	\$1,323
Services	do.	\$3,719	\$4,184	\$4,625
Government and government enterprises	do.	\$5,201	\$5,644	\$6,014

See footnotes at end of table.

Table 3.—Indicators of South Carolina business activity—Continued

	1984 <sup>†</sup>	1985	1986 <sup>‡</sup>
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> -----	36,081	32,815	26,840
Value of nonresidential construction <sup>4</sup> ----- millions-----	\$668.1	\$592.4	\$961.8
Value of State road contract awards <sup>5</sup> ----- do-----	\$178.6	\$224.0	\$316.6
Shipments of portland and masonry cement to and within the State thousand short tons--	1,100	1,138	1,188
<b>Nonfuel mineral production value:</b>			
Total crude mineral value----- millions-----	\$275.3	\$275.9	\$295.9
Value per capita-----	\$84	\$82	\$88

<sup>‡</sup>Preliminary. <sup>†</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

**Trends and Developments.**—The value of mineral production increased for the fourth consecutive year. Since the recession of 1981-82, the value of the State's mineral output has not fallen below that of the previous year. In 1982, mineral value fell \$11 million below that reported for 1981, primarily because of a \$13 million slump in cement sales.

Output of most mineral commodities increased, but sales of four were reported lower than in 1985: industrial sand, dimension stone, fuller's earth, and manganese ore. This decrease totaled less than \$2 million.

Highlighting the mineral news of the year were the announcements by two firms of plans to open new gold mines in the

State. Ridgeway Mining Inc., a division of Amselco Exploration Inc., released tentative plans to mine two deposits in Fairfield County near the community of Ridgeway, and Brewer Gold Co., a subsidiary of Westmont Mining Inc., announced plans to develop a gold property west of Jefferson in Chesterfield County.

One of the State's brick companies was acquired by a Georgia firm, and two were purchased by a Canadian company.

At yearend, Texaco Inc. was drilling a stratigraphic test well in the buried Florence (Triassic-Jurassic) Basin northwest of Lake City. The well was permitted to 6,000 feet (1,818 meters). No hydrocarbon test holes were to be drilled until data from the stratigraphic test were analyzed.



**Legislation and Government Programs.**—In June, the Governor signed Senate bill 906 creating a State Board of Registration for Geologists. After June 1987, a person engaged in the public practice of geology in South Carolina must be licensed by the State board.

During 1986, the South Carolina Geological Survey continued its basic programs to

encourage responsible development of the State's mineral resources. Work continued on field mapping for the new State geologic map; fieldwork was scheduled for completion by the end of 1988. Approximately 25 geologic field and laboratory projects were initiated, continued, or ongoing during 1986.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

In 1986, nine industrial minerals were mined in the State. These were produced by 191 companies operating 415 mines or pits.

**Cement.**—South Carolina ranked fourth among the 37 masonry cement-producing States. Raw materials were mined from

local marl and clay deposits, and gypsum was imported from foreign sources.

Each of the three cement companies produced portland cement Types I and II, and Giant Portland & Masonry Cement Co. and Santee Portland Cement Co. also produced masonry cement.

Table 4.—South Carolina: Cement industry in 1986

Company	Location	Process	Number of kilns	Annual clinker capacity (thousand short tons)	Primary fuel
Giant Portland & Masonry Cement Co	Harleyville	Wet	4	770	Coal.
Gifford-Hill & Co. Inc	do	Dry	1	550	Do.
Santee Portland Cement Co	Holly Hill	Wet	2	1,060	Do.

**Clays.**—Clay accounted for 12% of the 1986 mineral value for South Carolina. Based on information developed by the South Carolina Geological Survey 17 companies operated 45 mines. The State ranked 7th among the 44 States reporting clay production; output consisted of kaolin and common clay. The State's single fuller's earth operation, active for many years, terminated production in 1986.

**Kaolin.**—Five companies reported industrial kaolin production from 14 surface mines in Aiken County, while 7 companies produced kaolin for making brick from 13 mines in 6 counties. Kaolin production was from a belt that extends from the south-central part of the State to east-central Georgia.

Production increased 196,000 short tons over the amount reported in 1985. Mining

was by surface recovery methods, and both truck and pipeline were used to transport the raw clay to the plant. Air-float and water-washed processing methods were used in the beneficiation phase to produce a processed kaolin for a variety of markets.

Table 5.—South Carolina: Kaolin industry in 1986, by type

Type	County	Number	
		Companies	Mines
Industrial	Aiken	4	14
Brick	do	2	2
	Calhoun	1	1
	Chesterfield	1	1
	Kershaw	3	4
	Lexington	2	3
	Richland	2	2



**Table 6.—South Carolina: Kaolin sold or used by producers, by kind and use**

(Short tons)

Kind and use	1985	1986
Air-float: <sup>1</sup>		
Adhesives	14,528	17,483
Animal feed and pet waste absorbent	5,333	3,603
Ceramics <sup>2</sup>	13,542	3,637
Fertilizers, pesticides and related products	33,855	6,732
Fiberglass	67,095	99,393
Paint	364	580
Paper coating and filling	1,843	8,644
Plastics	13,051	9,581
Rubber	188,945	235,142
Refractories <sup>3</sup>	30,052	5,693
Other uses <sup>4</sup>	85,495	82,743
Exports <sup>5</sup>	50,227	33,474
Total	504,330	506,705
Unprocessed: Face brick and other uses	362,482	556,383
Grand total	866,812	1,063,088

<sup>1</sup>Includes water-washed.<sup>2</sup>Includes floor and wall tile, pottery, and roofing granules.<sup>3</sup>Includes refractory calcines and grogs; refractory mortar and cement; high-alumina refractories; and firebrick, blocks, and shapes.<sup>4</sup>Includes animal oil; catalysts (oil-refining); chemical manufacturing; ink, medical; sewer pipe; and unknown uses.<sup>5</sup>Includes ceramics, adhesives, paper filling, pesticides and related products, and rubber.

**Common Clay.**—Common clay was produced by 12 companies operating 18 pits in 14 counties. Output was used primarily for brick and cement manufacture.

Other activity in the State's clay industry included the purchase of Ashe Brick Co. in Van Wyck by the Merry Co. of Augusta, GA. Borden Clay Products Co. and Richtex Corp. were purchased by Toronto-based Jennock Ltd.

**Colemanite.**—Fiberglass companies in both North Carolina and South Carolina imported calcium borate minerals, primarily colemanite and ulexite from Turkey, for use in fiberglass manufacture. The Turkish ore was shipped through the Port of Charleston and then by rail to Kings Creek in Cherokee County. Industrial Minerals Inc. operated a custom grinding facility at the Kings Creek location and ground the borate minerals to fiberglass company specifications.

**Feldspar.**—Spartan Minerals Corp. in Pacolet, a subsidiary of Lithium Corp. of America (Lithcoa), ground a feldspar-silica concentrate that was recovered from Lithcoa lithium ore beneficiation facilities at Cherryville, NC. Principal sales were to the glass and whiteware industries. The material was also used as a filler in some industrial applications.

**Graphite (Synthetic).**—Union Carbide Corp. produced graphite fiber at a plant in Greenville, and the Aircro Carbon Div. of BOC Inc. produced graphite electrodes at a

plant in Ridgeville. Much of the output from Union Carbide's 1-million-pound-annual-capacity facility was used in the manufacture of graphite-epoxy composites.

**Mica.**—The Mineral Mining Corp. (Minco) produced sericite from a deposit adjacent to the gold ore zone at the Haile Gold Mine in Lancaster County. The sericite was trucked to the Minco plant northeast of Kershaw, where it was dry-ground and bagged. The primary market was the paint industry in the United States and Canada.

Spartan Minerals, dry-ground mica at a plant in Pacolet. The mica is recovered from spodumene beneficiation at Cherryville, NC, and trucked to the Pacolet facility. Principal sales were to the joint compound industry.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

In 1986, 38 companies reported production from 54 pits in a 24-county area. Lexington was the leading county with 14% of the State's total, followed by Sumter (12%) and Lancaster (10%).

Production increased approximately 2.3 million short tons over the estimate for 1985 because of the increase in the State's construction activity.

**Table 7.—South Carolina: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per short ton
Concrete aggregates (including concrete sand) -----	3,199	\$10,932	\$3.42
Plaster and gunita sands -----	370	1,009	2.73
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	668	1,159	1.74
Asphaltic concrete aggregates and other bituminous mixtures -----	849	2,834	3.34
Fill -----	1,530	2,467	1.61
Snow and ice control -----	W	W	2.67
Other <sup>1</sup> -----	65	147	2.26
Other unspecified <sup>2</sup> -----	519	1,233	2.37
Total or average -----	7,200	\$19,783	2.75

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

<sup>1</sup>Includes roofing granules.

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—Six companies produced industrial sand from six mines in a three-county area. Three operations were in Lexington County, two in Kershaw, and one in Cherokee.

Leading markets for the State's industrial sand output were (1) fiberglass manufacture, (2) container manufacture, and (3) for sandblasting purposes.

**Slag.**—Ferroalloy slag from the chrome ferroalloy plant in Charleston was crushed and ground, and a metal fraction was recovered by heavy-media separation. The remaining slag was marketed as aggregate, refractory material, and for roofing shingle applications. Slag from the State's three steel mills was sold for aggregate applications.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—In 1985, the last year reported, crushed stone was produced by 15 companies operating 27 quarries in 19 counties. The estimated production for 1986 exceeded the previous year's reported output by 1.1 million short tons.

**Dimension.**—Granite dimension stone was quarried by five companies operating eight quarries in Kershaw and Lancaster Counties. Output consisted of rough block and monumental stone. Some of the State's granite block output was shipped to Elberton, GA, for finishing.

**Vermiculite.**—South Carolina ranked second in vermiculite production. Principal sales were for lightweight aggregate, loose fill insulation, and horticultural applications. Three exfoliation plants were in operation in Laurens County, two owned by

W. G. Grace & Co. and one by Patterson Vermiculite Co.

## METALS

**Aluminum.**—Alumax Inc. operated South Carolina's only aluminum smelter, in Berkeley County. The 181,000-metric-ton facility, which housed two potlines, produced billets, ingots, and slabs from alumina imported from Australia.

**Copper.**—AT&T Nassau Metals Corp. operated a copper recycling facility at Gaston. The Gaston facility consisted of a scrap handling and upgrading section, a three-story secondary smelter, an electrolytic refinery, and a continuous cast copper wire plant.

**Ferroalloys.**—Macalloy Corp. operated the only significant domestic 50% to 55% charge chrome ferroalloy plant in the United States. The facility, in Charleston, was equipped with a 36,000- and 40,000-kilowatt furnace. Furnace feed was obtained from foreign sources and from the General Services Administration (GSA) stockpile in Montana.

A new ferroalloy-upgrading contract was signed by Macalloy and GSA, which required the upgrading of 271,574 short tons of chromite ore through 1988. The contract included an option for a third year, 1989, during which ferrochromium would be produced from 124,627 tons of chromite from the National Defense Stockpile.

**Germanium.**—Pirelli Cable Corp. of Union, NJ, completed the construction of a fiber optic cable manufacturing facility near Lexington. A germanium compound is a major constituent in optical fibers used in the manufacture of high-index optical core cable. This was the third Pirelli plant producing fiber optic cables in North America; the others were in Wallingford, CT, and Surrey, British Columbia, Canada.

**Gold.**—Piedmont Mining Co. continued as the only major gold producer in the Southeast. The Piedmont operation was at the old Haile Mine in Lancaster County, 3 miles northeast of Kershaw. During the first 12 months of operation, April 1985 to March 1986, production totaled more than 7,600 troy ounces of gold.<sup>3</sup>

Nine miles northeast of the Haile Mine, Brewer Gold, a subsidiary of Westmont, was developing the Brewer deposit west of Jefferson. Westmont had been exploring the deposit for approximately 4 years. Ore reserves were reported to be sufficient for a minimum of 7 years production at a rate of 25,000 troy ounces of gold per year. Operations were scheduled to begin in the summer of 1987.

Westmont purchased a cyanide-leach carbon-recovery mill from Scotia Systems Inc. of Salt Lake City, UT. The skid-mounted mill was to be shipped disassembled on seven trucks for reassembly at the deposit. Most of the skid structures were 43 feet in length and 10 feet wide. The mill was to be disassembled and transported to another

site after the Brewer ore body has been exhausted.<sup>4</sup>

Thirty miles south of the Haile Mine, Amselco Minerals Inc., a wholly-owned subsidiary of British Petroleum Co. PLC, and Galactic Resources Ltd. of Canada were developing a gold property near Ridgeway in Fairfield County. Two deposits have been outlined that contain an estimated 51 million short tons of 0.039 troy ounce per ton of gold ore calculated by using a mining cutoff grade of 0.023 troy ounce per ton of gold and a 1:1 ore-to-waste stripping ratio. Company plans were to vat-leach the ore after grinding, a departure from the heap leach method planned for the Brewer deposit and used at the Haile operation. A feasibility study indicated an annual gold production of 160,000 troy ounces at cash operating costs of approximately \$145 per troy ounce. Capital costs have been estimated at \$84 million.<sup>5</sup>

**Iron and Steel.**—South Carolina's steel industry was composed of 3 companies operating 10 electric arc furnaces. Information on the industry is as follows:

Company	Location	Number of furnaces	Size (short tons per heat)	Plant capacity (short tons)
Georgetown Steel Corp. -----	Georgetown ----	2	75	687,000
Nucor Corp. -----	Darlington ----	5	32	550,000
Owen Electric Steel Co. -----	Columbia ----	3	--	150,000

In the fourth quarter, a company spokesperson for Georgetown Steel Corp. indicated that shipments were running 15% ahead of that of 1985. Business at the company, primarily a wire rod producer, was up because of a decline in wire rod imports, a lack of inventory by customers, and the chapter 11 bankruptcy filing of a competitor.

At Nucor Corp., shipments were about equal with those of 1985. Data were not available on Owen Electric Steel Co. shipments.<sup>6</sup>

**Manganiferous Ore.**—Five companies in Cherokee County in the northern part of the State mined manganiferous rock from zones in the Battleground Schist. The material was used in brick coloring.

**Platinum.**—Engelhard Corp. continued construction on its \$25 million custom catalyst plant near Seneca. The plant, scheduled for completion in the second half of 1987, will use palladium, platinum, rhodium, and ruthenium to produce catalysts for the auto-

mobile, chemical, film, and petroleum industries.

**Silver.**—An increased amount of silver was recovered during the refining of doré bullion from the Haile Mine near Kershaw. Silver comprised approximately 30% of the bullion generated at the mine.

**Zircon.**—M & T Chemicals Inc. operated a zircon grinding plant at Andrews. Zircon concentrate, recovered during titanium mineral beneficiation, was imported from Australia and Florida. Ground zircon from the Andrews facility was sold to the ceramics, foundry, wall tile, and whiteware industries.

<sup>1</sup>State mineral officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Chief, Mineral Resources, South Carolina Geological Survey, Columbia, SC.

<sup>3</sup>Skillsings Mining Review. Piedmont Mining Co. Marked Second Year of Operation at Haile Mine, Only Gold Producer in SE US. June 28, 1986, p. 4.

<sup>4</sup>Salt Lake Tribune. Work on Gold Mill Nears Completion in Salt Lake. May 31, 1987.

<sup>5</sup>International Mining. South Carolina. July 1986, p. 47.

<sup>6</sup>American Metals Market. Most Mini-Mills in US Running Near Capacity. Nov. 7, 1986.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum (smelters):</b>			
Alumax Inc -----	Box 1000 Goose Creek, SC 29445	Plant -----	Berkeley.
<b>Cement:</b>			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	---do-----	Dorchester.
Gifford-Hill & Co. Inc -----	Box 326 Harleyville, SC 29448	---do-----	Do.
Santee Portland Cement Co -----	Box 698 Holly Hill, SC 29059	---do-----	Orangeburg.
<b>Clays:</b>			
Common clay and shale:			
Gifford-Hill & Co. Inc -----	Box 326 Harleyville, SC 29448	Mines and plant	Dorchester.
Palmetto Brick Co. <sup>1</sup> -----	Box 430 Cheraw, SC 29520	---do-----	Chesterfield and Marlboro.
Richtex Corp. <sup>1</sup> -----	Box 3307 Columbia, SC 29230	---do-----	Lexington and Rich- land.
Santee Portland Cement Co -----	Box 698 Holly Hill, SC 29059	---do-----	Orangeburg.
Southern Brick Co -----	Box 208 Ninety Six, SC 29666	---do-----	Greenwood, New- berry, Saluda.
<b>Kaolin:</b>			
Cyprus Industrial Minerals Co ---	7000 South Yosemite St. Englewood, CO 80155	---do-----	Aiken.
W. R. Grace & Co., a subsidiary of National Kaolin Products Co.	Box 2768 Aiken, SC 29802	---do-----	Do.
J. M. Huber Corp -----	Route 4 Huber Macon, GA 31298	---do-----	Do.
Richtex Corp -----	Box 3307 Columbia, SC 29230	---do-----	Lexington and Rich- land.
<b>Colemanite:</b>			
Industrial Minerals Inc -----	Box 459 York, SC 29745	Plant -----	York.
<b>Feldspar:</b>			
Spartan Minerals Corp., a subsidiary of Lithium Corp. of America.	Box 520 Pacolet, SC 29372	---do-----	Spartanburg.
<b>Manganiferous ore:</b>			
Ashe Brick Co -----	Van Wyck, SC 29744	Mine and plant	Do.
Broad River Brick Co., a division of Borden Clay Products Co.	Box 368 Pleasant Garden, NC 27313	---do-----	Do.
Fletcher Brick Co., a division of Moland-Drysdale Corp.	Box 2150 Hendersonville, NC 28739	---do-----	Do.
<b>Mica (sericite):</b>			
Mineral Mining Corp -----	Box 458 Kershaw, SC 29067	---do-----	Lancaster.
<b>Sand and gravel:</b>			
Becker Sand and Gravel Co. Inc -----	Box 848 Cheraw, SC 29520	Pits and plants	Chesterfield, Dorchester, Flor- ence, Marlboro, Sumter.
Brewer Sand Co. Inc -----	Box 267, Route 2 Lancaster, SC 29720	Pit and plant	Lancaster.
Foster-Dixiana Sand Co -----	Box 5447 Columbia, SC 29250	---do-----	Lexington.
<b>Stone (1985):</b>			
<b>Granite:</b>			
Crushed:			
Lone Star Industries Inc ---	515 West Greens Rd. Houston, TX 77067	Quarries and plant.	Fairfield, Green- wood, Richland.
Martin Marietta Aggregates	Box 30013 Raleigh, NC 27612	---do-----	Fairfield, Lexington, Richland, York.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	---do-----	Greenville, Laurens, Pickens, Spartan- burg.
Dimension:			
Granite Panelwall Co., a division of Florida Crushed Stone Co.	Box 898 Elberton, GA 30635	Quarry -----	Kershaw.
Mathews International Corp	Box 606 Kershaw, SC 29067	---do-----	Do.
<b>Limestone (crushed):</b>			
Martin Marietta Aggregates ---	Box 30013 Raleigh, NC 27612	Quarry and plant	Berkeley and Georgetown.
Southern Aggregates Co -----	Box 4510 Augusta, GA 30907	---do-----	Berkeley.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	---do-----	Cherokee.
<b>Marl (crushed):</b>			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	Pit -----	Dorchester.
Gifford-Hill & Co. Inc -----	Box 326 Harleyville, SC 29448	Pit -----	Do.
Santee Portland Cement Co -----	Box 698 Holly Hill, SC 29059	Pit -----	Orangeburg.

See footnote<sup>1</sup> at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Vermiculite:			
Carolina Vermiculite Co. Inc.-----	Box 98 Woodruff, SC 29388	Mines and plant	Spartanburg.
W. R. Grace & Co.-----	Route 1 Enoree, SC 29335	do-----	Laurens.
Patterson Vermiculite Co.-----	do-----	do-----	Do.

<sup>1</sup>Also kaolin.

# The Mineral Industry of South Dakota

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

By Leon E. Esparza<sup>1</sup>

In 1986, the value of South Dakota's nonfuel mineral production was almost \$233 million, an increase of 12% over the 1985 value. The growth was attributed to increases in production and value of gold, lime, and construction sand and gravel. Declining interest rates helped boost building construction, which increased demand for most mineral commodities used in construction. Precious metals production and value increased mostly because of increased metals prices. South Dakota ranked 34th in the Nation for value of nonfuel mineral production.

Table 1.—Nonfuel mineral production in South Dakota<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons...	5	\$283	4	W	4	W
Portland ----- do. ....	619	30,773	655	W	635	W
Clays <sup>2</sup> ----- do. ....	119	343	117	\$309	119	\$375
Feldspar ----- short tons...	7,219	124	13,721	W	W	W
Gem stones -----	NA	<sup>e</sup> 70	NA	<sup>e</sup> 70	NA	100
Gold (recoverable content of ores, etc.)						
troy ounces...	310,527	111,994	356,103	113,119	W	W
Gypsum ----- thousand short tons...	W	W	34	269	31	268
Sand and gravel (construction) ----- do. ....	5,786	12,168	<sup>e</sup> 6,400	<sup>e</sup> 16,000	9,713	19,853
Silver (recoverable content of ores, etc.)						
thousand troy ounces...	50	407	63	388	W	W
Stone:						
Crushed ----- thousand short tons...	<sup>e</sup> 3,800	<sup>r</sup> 12,800	4,071	14,412	<sup>e</sup> 3,600	<sup>e</sup> 12,600
Dimension ----- do. ....	<sup>r</sup> 57	<sup>r</sup> 18,032	<sup>r</sup> 51	<sup>r</sup> 18,336	<sup>e</sup> 55	<sup>e</sup> 18,399
Combined value of beryllium, clays (bentonite), lime, mica (scrap), and values indicated by symbol W -----	XX	11,265	XX	<sup>r</sup> 44,800	XX	181,291
Total -----	XX	<sup>r</sup> 198,259	XX	<sup>r</sup> 207,703	XX	232,886

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes bentonite; value included with "Combined value" figure.

**Table 2.—Nonfuel minerals produced in South Dakota in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Butte	Clays.
Custer	Stone (crushed), feldspar, mica, beryllium.
Fall River	Stone (crushed).
Grant	Stone (dimension).
Hanson	Stone (crushed).
Lawrence	Gold, stone (crushed), silver.
Minnehaha	Stone (crushed).
Pennington	Cement, stone (crushed), lime, clays, gypsum.
Yankton	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.**Table 3.—Indicators of South Dakota business activity**

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	705	708	708
Total civilian labor force	do	344	343	345
Unemployment	percent	4.3	5.1	4.7
<b>Employment (nonagricultural):</b>				
Mining total	thousands	2.7	2.5	2.6
Oil and gas extraction <sup>1</sup>	do	.2	.1	.1
Manufacturing total	do	29.2	27.5	28.3
Stone, clay, and glass products <sup>1</sup>	do	1.1	1.1	1.1
Chemicals and allied products <sup>1</sup>	do	.2	.3	.3
Construction	do	9.3	9.5	9.6
Transportation and public utilities	do	12.3	12.7	12.6
Wholesale and retail trade	do	65.3	65.9	65.6
Finance, insurance, real estate	do	13.1	14.0	14.2
Services	do	57.8	59.3	60.1
Government and government enterprises	do	57.2	57.9	58.7
Total <sup>2</sup>	do	247.0	249.4	251.6
<b>Personal income:</b>				
Total	millions	\$7,465	\$7,815	\$8,364
Per capita		\$10,586	\$11,034	\$11,814
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		42.1	41.8	42.0
Total average hourly earnings, production workers		\$7.1	\$7.4	\$7.7
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$603	\$675	\$883
Nonfarm	do	\$4,476	\$4,673	\$4,907
Mining total	do	\$86	\$88	\$92
Metal mining	do	\$53	\$54	\$59
Nonmetallic minerals except fuels	do	\$22	\$21	\$20
Oil and gas extraction	do	\$10	\$13	\$13
Manufacturing total	do	\$539	\$533	\$575
Primary metal industries	do	\$6	\$6	\$7
Stone, clay, and glass products	do	\$23	\$24	\$24
Chemicals and allied products	do	\$4	\$5	\$6
Construction	do	\$278	\$294	\$317
Transportation and public utilities	do	\$420	\$425	\$432
Wholesale and retail trade	do	\$914	\$939	\$951
Finance, insurance, real estate	do	\$266	\$293	\$320
Services	do	\$968	\$1,054	\$1,127
Government and government enterprises	do	\$959	\$1,010	\$1,052
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup>		3,221	2,544	1,981
Value of nonresidential construction <sup>4</sup>	millions	\$101.0	\$90.4	\$106.4
Value of State road contract awards <sup>5</sup>	do	\$101.3	\$90.4	\$132.2
Shipments of portland and masonry cement to and within the State	thousand short tons	228	296	336
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$198.3	\$207.7	\$232.9
Value per capita		\$281	\$293	\$329

<sup>p</sup>Preliminary. <sup>f</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—Environmental concerns about reclamation of open pit gold mines and the effects of cyanide heap-leaching methods on ground water gained a wider audience during 1986. The concerns grew because of increased exploration and announced intentions by several mining companies to mine gold near Lead, in Lawrence County. Additionally, Homestake Mining Co. resumed gold mining operations at its Lead Open Cut Mine, which had been idle since 1945. Advances in

heap-leach technology in recent years have resulted in improved economics for mining large, low-grade gold deposits. This in turn has spawned an increase in exploration activity in the Black Hills by foreign and domestically owned mining companies. Ten life-of-mine permits, summarized in table 4, were issued by the State during 1986. These permits also reflected increased precious metals activity; four of them were issued for gold-silver operations in 1986 compared with one during 1985.

**Table 4.—South Dakota: Life-of-mine permits issued in 1986**

Company	County	Commodities
A & H Mining	Custer	Pegmatite minerals.
Gilt Edge Inc. (Brohm Resources Inc.)	Lawrence	Gold and silver.
Pacer Corp. <sup>1</sup>	Custer	Pegmatite minerals.
South Dakota Cement Commission	Pennington	Limestone.
Do	do	Shale.
Trojan Mining Co.	Lawrence	Gold and silver.
Wharf Resources (U.S.A.) Inc. <sup>2</sup>	do	Do.

<sup>1</sup>3 permits issued.

<sup>2</sup>2 permits issued.

Source: South Dakota Department of Water & Natural Resources, Exploration and Mining Program.

**Employment.**—Mining employment for 1986 increased 4%, to 2,600 workers, compared with that of 1985.<sup>2</sup> This was the largest percentage growth among industries for which the South Dakota Department of Labor compiled statistics.

**Exploration Activities.**—During 1986,

gold exploration in the Northern Black Hills continued at the near feverish pace witnessed in 1985. Of the 18 new exploration permits issued by the State in 1986, 15 were for gold and other precious metals. A summary of permitting activities is provided in table 5.

**Table 5.—South Dakota: Exploration permits issued in 1986**

Company	County	Commodities
FMC Corp.	Custer	Precious metals.
Frank Fowler & Associates	do	Gold and garnets (placers).
Freeport-McMoRan Gold Co.	Pennington	Precious and base metals.
Gilt Edge Inc. (Brohm Resources Inc.)	Lawrence	Gold.
Homestake Mining Co.	do	All minerals, except uranium.
Meridian Minerals Co. <sup>1</sup>	Minnehaha	Quartzite.
Moruya Gold Mines of North America Inc.	Lawrence	Gold and silver.
Noranda Exploration Inc.	Pennington	Do.
SABA Resources Corp.	Butte	Do.
St. Joe American Corp. <sup>2</sup>	Lawrence	Do.
Seis Pros Services Inc.	Harding	Oil and gas.

<sup>1</sup>2 permits.

<sup>2</sup>7 permits.

Source: South Dakota Department of Water & Natural Resources, Exploration and Mining Program.

Wharf Resources Ltd. reported 57,884 feet of exploration drilling in 1986. All of the drilling was done to define additional reserves at its Annie Creek-Foley Ridge Mine in Lawrence County. St. Joe Gold Corp. continued drilling exploration in the vicinity of its Richmond Hill-Turn-around de-

posit in the Carbonate Mining District in Lawrence County.

**Legislation and Government Programs.**—There were two mineral industry-related laws enacted during 1986. One requested a 1986 interim study regarding the social and economic effects of surface min-

ing. The other revised certain severed mineral interest taxation provisions.

Legislation was enacted that allows minting of South Dakota centennial commemorative coins. A contractor would mint 0.999 fine gold or silver coins, sell them and pay the State a royalty for use of the State seal.

The South Dakota Geological Survey, in a cooperative effort with the U.S. Geological Survey, continued its geologic-hydrologic mapping program of the eastern South Dakota counties. Sand and gravel resource evaluations were included in the mapping effort.

In September, results were released on a study by Engineering-Science of Denver, CO, of heap-leach technology and potential environmental effects in the Black Hills.<sup>3</sup> The study was done on behalf of the U.S. Environmental Protection Agency, Water

Management Division. The study indicated that since a cyanide heap-leach facility is a closed system and would not ordinarily discharge fluids to surface or ground water, impacts from a properly designed and operated project would not be a greater threat to the environment than projects not using cyanide. It further stated that in the unlikely event of a discharge, most impacts would be short term because of dilution and cyanide attenuation.

The U.S. Bureau of Mines distributed \$142,000 to the State's Mining and Mineral Resources and Research Institute of the South Dakota School of Mines and Technology at Rapid City. The funds were provided as part of a program to assist the institute's efforts in training engineers and scientists in mineral-related disciplines.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### METALS

Metal production accounted for over one-half of the State's mineral value in 1986. South Dakota was the site of the second largest gold-producing mine in the country and ranked third of 15 States in gold production.

**Beryllium.**—Pacer Corp. produced beryl, feldspar, and mica from pegmatite deposits in Custer County. Production and value increased markedly compared with 1985 figures. The increases were attributed to

the corporation's resumption of purchases from small mining operations and intensified marketing efforts.

**Gold.**—South Dakota ranked behind Nevada and California, which ranked first and second, respectively, in gold production. According to Homestake Mining Co. and Wharf Resources Ltd. annual reports to stockholders, gold production totaled 367,715 ounces. The average gold price in 1986 was about \$368 per troy ounce.

Table 6.—South Dakota: Mine production of gold and silver in terms of recoverable metal

Year	Mines producing		Material sold or treated <sup>1</sup> (thousand metric tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)
1982	1	--	1,059	185,038	\$69,558	26	\$209
1983	2	--	1,771	309,784	131,348	62	713
1984	2	--	2,252	310,527	111,994	50	407
1985	2	--	2,309	356,103	113,119	63	388
1986	3	--	W	W	W	W	W
1876-1985	NA	NA	NA	38,970,185	2,103,130	13,706	16,318

NA Not available. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Excludes placer gravel.

Homestake was the State's largest gold producer. In February, the company began excavation of about 25 million cubic yards of overburden and ore at its Open Cut Mine at Lead. Excavation was expected to cost about \$56 million and to take 5 years. Life of the mine, based on 1986 economics,

was expected to be about 15 years. The Open Cut is the site of the original discovery, in 1877, which would become the Homestake Mine. The Open Cut was last mined in 1945 after removal of about 40 million short tons of ore.<sup>4</sup> Ore reserves total about 6.5 million tons, with an average

grade of 0.127 troy ounce per ton.<sup>5</sup> During 1986, ore was hauled to Homestake's South Mill by dump truck. At yearend, construction was essentially completed on a new crusher and pipe conveyor system at the Open Cut. The conveyor will span 6,600 feet and was designed to transport 350 tons of ore per hour. It was the first of its kind in the United States and the longest in the world. The company expects the system will improve mining economics and safety by eliminating the need to haul ore by truck through the town of Lead; thereby reducing dust and noise problems. At yearend, more than 13.1 million tons of ore and waste had been mined and nearly 32,000 ounces of gold recovered. The project was expected to become fully operational in March 1987.

Mining and exploration work at the Homestake Mine continued below the 6,800-foot level. Major development work occurred on the 6,950, 7,100, 7,250, 7,550, 7,700, and 8,000-foot levels. Late in the year, sinking of the No. 4 Winze from the 6,950- to 7,450-foot level was begun. Exploration drilling also continued below 8,000 feet. Homestake Mine ore reserves totaled about 18.8 million tons with an average grade of about 0.212 troy ounce per ton. Average grade of ore from underground operations in 1986 was 0.174 ounce per ton, and total gold production was 341,647 ounces. The company also reported an average production cost of \$298 per ounce in 1986, an increase over the \$294 per ounce reported in 1985. Overall grade of ore milled improved slightly, and mill recovery improved to 94.7%.<sup>6</sup>

A new 3-year labor contract signed during the year will be in effect until May 31, 1989.

Wharf Resources (U.S.A.) Inc., a wholly owned subsidiary of Wharf Resources Ltd., a Canadian company continued operations at its Annie Creek-Foley Ridge deposit in the Bald Mountain Mining District west of Lead. According to the Wharf annual report to shareholders, gold production was a little over 26,000 troy ounces. Average ore grade for the deposit was 0.048 ounce of gold per ton, and average cash operating cost per ounce of gold sold was \$176.

In June, Wharf essentially completed mining the Annie Creek open pit and began opening the Foley Ridge North and South Pits. Construction on Heap Leach Pad No. 3 also was begun. In April, the company completed purchase of the remaining interest of Homestake in the Foley Ridge deposit. During 1986, Wharf also upgraded its

facilities, which will increase ore production to about 1.2 million tons per year by using a load-unload leach pad system. A tertiary crushing system that will reduce the size of crushed ore to about one-half inch was installed. This additional crushing step will allow the company to convert its heap-leach system from 100-foot-high heaps to 20-foot-high heaps. The smaller heaps will shorten the time needed for cyanide leaching of the rock from 350 to 60 days and will increase gold recovery from about 70% to 74%. After the leaching cycle has been completed, the heaps will be neutralized with hydrogen peroxide solution to reduce the residual sodium cyanide content to acceptable levels. Once the waste residue is neutralized, it will be hauled to a disposal site and the leach pads will be reused. The transition to 20-foot heaps was expected to be completed in 1988 if the neutralizing procedure proves satisfactory.

St. Joe Gold, a subsidiary of St. Joe Minerals Corp., continued evaluation of its Richmond Hill deposit in the Carbonate District near Lead. The project is a joint venture between St. Joe Gold and Viable Resources Inc. of Casper, WY. St. Joe Gold controlled about 6 square miles around the old Carbonate Mine. Drilling outlined a gold deposit reaching to depths of about 245 feet that may be amenable to heap-leach processing. Preliminary ore reserve estimates ranged from 3 to 6 million tons.<sup>7</sup> In June, St. Joe Gold began a feasibility study to determine whether it should file for a State mining permit for the Richmond Hill deposit and the nearby Turnaround deposit.

Brohm Resources Inc. completed the permitting process for the Gilt Edge Project in Lawrence County. Brohm bought the Lacana Gold Inc. interest in the Gilt Edge gold mine in February. Life of the mine is expected to be 7 to 10 years, with production rates up to 750,000 tons of ore per year.<sup>8</sup>

Golden Reward Mining Co.—a joint venture composed of Moruya Gold Mines (1983) NL of Australia, Coin Lake Gold Mines Ltd. of Canada, and Ventures Trident of Colorado—continued exploration and environmental assessment of its property southwest of Lead. The Coin Lake 1986 annual report to stockholders stated that ore reserves at a cutoff grade of 0.03 ounce of gold per ton totaled about 3.2 million tons with an average grade of 0.079 ounce of gold per ton.

**Silver.**—Homestake continued to produce silver as a coproduct from mining oper-

ations at the Homestake Mine. Production and value posted increases in 1986 compared with 1985 figures. Average silver price for the year was about \$5.47 per troy ounce.

### INDUSTRIAL MINERALS

**Cement.**—Portland cement sales and attendant value decreased about 3% in 1986. Masonry cement sales for the same period declined about 5% in both quantity and value. The only government-owned cement plant in the Nation, and the only plant in South Dakota, is operated by the State. The business is administered by the seven-member South Dakota Cement Commission, which is appointed by the Governor. The facility can produce up to 1 million short tons of cement per year. Cement products are marketed in South Dakota, its six adjacent States, and Colorado. About 57% of the finished portland cement was sold to ready-mixed concrete companies, 11% to highway contractors; 19% to other contractors; and 13% to various other consumers.

**Clays.**—The South Dakota Cement Commission mined common clay and shale in Pennington County for its own use in the State-owned cement plant at Rapid City. Production and value increased about 2% and 21%, respectively.

Crude bentonite was mined in Butte County by American Colloid Co. and processed at its Belle Fourche plant. The product was sold for more than 2 dozen uses, including animal feed additive, drilling muds, foundry sand, pelletizing iron, and waterproofing and sealing. Production increased over that of 1985.

**Feldspar.**—In 1986, Pacer was the only processor of feldspar in South Dakota. Production decreased slightly. Pacer owns several surface mines and a crushing plant in Custer County. Ore from the pegmatite district of the Southern Black Hills is mined by Pacer and about 25 independent mine operators. After crushing at Pacer's plant in Custer, the product is sold in bulk and bag form to the electrical, porcelain, and pottery industries.

**Gem Stones.**—The collection of gem

stones and mineral specimens was a small but active facet of the mineral industry. Production statistics are not available; however, value was estimated to have increased about 43%. Several varieties of agate are found in the State, as are many types of vertebrate and invertebrate fossils.

**Gypsum.**—In 1986, crude gypsum production was down about 9% and value was basically unchanged. The South Dakota Cement Commission surface mined crude gypsum from a deposit in Pennington County where it was crushed and shipped by rail to the commission's cement plant in Rapid City.

**Lime.**—Pete Lien & Sons Inc. produced both hydrated lime and quicklime at a plant in Rapid City and was the only producer in South Dakota. In 1986, production and value increased about 27% and 47%, respectively. Limestone was supplied from a surface mine in Pennington County.

**Mica.**—Mica production during 1986 increased about 113%, and value increased 81%. The substantial increases were due to intensified efforts by Pacer to identify new markets.

**Sand and Gravel (Construction).**—Construction sand and gravel is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

South Dakota's sand and gravel production in 1986 increased 52% in tonnage over that estimated for 1985 and reflected expanded survey coverage. A total of 162 firms and government agencies reported production from 340 pits in 61 of the State's 66 counties. In the previous canvass year of 1984, production was reported by 106 entities that operated at 183 sites in 50 counties.

Principal producing counties, in descending order of production, were Minnehaha, Pennington, Codington, Brown, and Davison. Production from each was in excess of 500,000 tons, and together they accounted for over one-third of the State's output.

**Table 7.—South Dakota: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,148	\$4,205	\$3.66
Plaster and gunitite sands -----	8	38	4.75
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	W	W	3.58
Asphaltic concrete aggregates and other bituminous mixtures -----	1,366	3,122	2.29
Road base and coverings <sup>1</sup> -----	4,468	6,745	1.50
Fill -----	464	681	1.47
Snow and ice control -----	45	203	4.51
Railroad ballast -----	W	W	1.00
Other <sup>2</sup> -----	69	141	2.05
Other unspecified <sup>3</sup> -----	2,145	4,718	2.20
Total or average -----	9,713	19,853	2.04

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

<sup>1</sup>Includes road and other stabilization (cement).

<sup>2</sup>Includes roofing granules and data indicated by symbol W.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains only estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Estimated production and value of crushed stone in 1986 was down about 12% and 13%, respectively.

**Dimension.**—In 1986, estimated production increased about 8%, with value remaining about the same as that of 1985. Average value per short ton decreased 6%.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Minneapolis, MN.

<sup>2</sup>South Dakota Labor Bulletin. 1986 Nonfarm Employment in Review, Jan. 1987.

<sup>3</sup>U.S. Environmental Protection Agency, Water Management Division, State Programs Branch, Denver, CO. Heap Leach Technology and Potential Effects in the Black Hills. 1986, 367 pp.

<sup>4</sup>Atlas Blasting News. Blasting is Key Factor in Open Cut Project at Homestake Mine. Oct. 1986.

<sup>5</sup>Homestake Mining Co. 1986 Annual Report.

<sup>6</sup>Work cited in footnote 5.

<sup>7</sup>The Rapid City Journal. Another Company Exploring for Gold. June 23, 1986.

<sup>8</sup>Lead Daily Call. Canadian Firm Wants To Mine Gilt Edge. July 11, 1986.

**Table 8.—Principal producers**

Commodity and company	Address	Type of activity	County
Beryllium concentrate: Pacer Corp -----	Box 912 Custer, SD 57730	Mine and plant -----	Custer.
Cement: South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	3 rotary kilns -----	Pennington.
Clays: American Colloid Co -----	5100 Suffield Ct. Skokie, IL 60076	Open pit mine and plant. ---	Butte.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit mine -----	Pennington.
Feldspar: Pacer Corp -----	Box 912 Custer, SD 57730	Open pit mines and dry-grinding plant.	Custer.
Gold: Homestake Mining Co -----	Box 875 Lead, SD 57754	Underground and open pit mines, cyanidation mill, refinery.	Lawrence.
Wharf Resources (U.S.A.) Inc ..	Box 897 Lead, SD 57754	Open pit mine and heap leaching.	Do.
Gypsum: South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit mine -----	Pennington.
Lime: Pete Lien & Sons Inc -----	Box 440 Rapid City, SD 57709	1 rotary kiln, 1 vertical kiln, continuous-hydrator plant.	Do.
Mica: Pacer Corp -----	Box 912 Custer, SD 57730	Mine and dry-grinding plant	Custer.
Sand and gravel (construction): Birdsall Sand & Gravel Co. ---	Box 767 Rapid City, SD 57709	Pits and plants -----	Fall River, Pennington, Sully.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (construction) — Continued			
Fischer Sand & Gravel Co ---	Box 1034 Dickinson, ND 58601	Pits and plants -----	Charles Mix, Davi- son, Lawrence, Ziebach.
Mehlhoff Construction Co ---	Route 1, Box 25 Tripp, SD 57376	Pit and plant -----	Hutchinson.
Myrl & Roy's Paving Inc -----	1500 East 39th St. North Sioux Falls, SD 57101	Pits and plants -----	Minnehaha.
Sweetman Construction Inc ---	100 South Dakota Ave. Summit, SD 57266	---do -----	Minnehaha and Roberts.
Silver:			
Homestake Mining Co -----	Box 875 Lead, SD 57754	See "Gold" -----	Lawrence.
Stone (1985):			
Crushed:			
Limestone:			
Pete Lien & Sons Inc --	Box 440 Rapid City, SD 57709	Quarries and plants -----	Custer and Pen- nington.
Northwestern Engineer- ing Co. (Hills Materi- als Co.)	Box 2320 Rapid City, SD 57709	---do -----	Fall River and Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Quarry and plant -----	Pennington.
Sandstone-quartzite:			
Concrete Materials Co	Box 809 Sioux Falls, SD 57101	---do -----	Minnehaha.
L. G. Everist Inc ---	Box 829 Sioux Falls, SD 57101	---do -----	Do.
Spencer Quarries Inc	Box 25 Spencer, SD 57374	---do -----	Hanson.
Dimension:			
Granite:			
Cold Spring Granite Co.	202 South 3d Ave. Cold Spring, MN 56320	Quarries -----	Grant.
Dakota Granite Co --	Box 1351 Milbank, SD 57252	---do -----	Do.



# The Mineral Industry of Tennessee

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

By Doss H. White, Jr.,<sup>1</sup> Ray Gilbert,<sup>2</sup> and Gregory Upham<sup>2</sup>

Nonfuel mineral production in Tennessee reached a record high of \$482 million in 1986. The \$9 million increase over the 1985 value was due to a \$22 million increase in the value of construction sand and gravel and crushed stone, reflecting the health of the State's construction industry.

Unfortunately, the health of other sectors

of Tennessee's mineral industry did not parallel that of the construction industry. Approximately 400 jobs were lost when a phosphate company terminated operations in the fourth quarter, and an additional 800 were scheduled for termination in the summer of 1987 when the Tennessee Chemical Co. pyrite mine was scheduled to close.

Table 1.—Nonfuel mineral production in Tennessee<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays <sup>2</sup> ----- thousand short tons--	1,165	\$21,690	1,244	\$25,913	1,164	\$25,228
Gem stones-----	NA	<sup>e</sup> 5	NA	<sup>e</sup> 5	NA	W
Phosphate rock --- thousand metric tons--	1,368	33,275	1,233	<sup>r</sup> 27,000	1,232	27,000
Sand and gravel:						
Construction--- thousand short tons--	6,304	19,830	<sup>e</sup> 7,200	<sup>e</sup> 22,000	7,360	24,592
Industrial----- do-----	650	6,903	569	6,156	488	5,523
Stone:						
Crushed----- do-----	<sup>e</sup> 36,200	<sup>e</sup> 138,000	<sup>3</sup> 37,939	<sup>3</sup> 155,760	<sup>e</sup> 340,700	<sup>e</sup> 3175,600
Dimension----- do-----	<sup>r</sup> 6	<sup>r</sup> 1,849	<sup>r</sup> 6	<sup>r</sup> 1,856	<sup>e</sup> 6	<sup>e</sup> 1,553
Zinc (recoverable content of ores, etc.) metric tons--	116,526	124,854	104,471	92,971	102,118	85,550
Combined value of barite, cement, clays (fuller's earth), copper, lead (1984-85), lime, pyrites, silver, stone (crushed granite, 1985-86), and value indicated by symbol W	XX	131,918	XX	141,109	XX	136,610
Total-----	XX	<sup>r</sup> 478,324	XX	<sup>r</sup> 472,770	XX	481,656

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fuller's earth; value included with "Combined value" figure.

<sup>3</sup>Excludes crushed granite; value included with "Combined value" figure.



Table 2.—Nonfuel minerals produced in Tennessee in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Anderson	Stone (crushed), clays.
Bedford	Stone (crushed).
Benton	Stone (crushed), sand (industrial).
Bledsoe	Stone (crushed).
Blount	Stone (crushed), stone (dimension).
Bradley	Stone (crushed).
Campbell	Stone (crushed), sand (industrial).
Cannon	Stone (crushed).
Carroll	Sand (industrial), clays.
Carter	Stone (crushed).
Claiborne	Do.
Clay	Do.
Cocke	Do.
Coffee	Do.
Cumberland	Stone (crushed), stone (dimension).
Davidson	Stone (crushed).
Decatur	Do.
DeKalb	Do.
Dickson	Do.
Fentress	Stone (crushed), stone (dimension).
Franklin	Stone (crushed).
Gibson	Clays.
Giles	Phosphate rock, stone (crushed).
Grainger	Stone (dimension), stone (crushed).
Greene	Stone (crushed).
Grundy	Do.
Hamblen	Do.
Hamilton	Cement, stone (crushed), sand (industrial), clays.
Hancock	Stone (crushed).
Hardin	Do.
Hawkins	Do.
Henry	Clays, sand (industrial).
Humphreys	Stone (crushed).
Jefferson	Zinc, stone (crushed), copper, silver, lead.
Johnson	Stone (crushed).
Knox	Cement, stone (crushed), zinc, clays.
Lawrence	Stone (crushed).
Lincoln	Do.
Loudon	Stone (crushed), barite.
McMinn	Stone (crushed), lime.
Macon	Stone (crushed).
Marion	Do.
Marshall	Do.
Maury	Phosphate rock, stone (crushed).
Meigs	Stone (crushed).
Monroe	Do.
Montgomery	Do.
Moore	Do.
Overton	Do.
Polk	Pyrites, copper, zinc, silver.
Putnam	Stone (crushed).
Rhea	Do.
Roane	Do.
Robertson	Do.
Rutherford	Do.
Sequatchie	Do.
Sevier	Do.
Smith	Zinc, stone (crushed).
Stewart	Stone (crushed).
Sullivan	Stone (crushed), clays.
Sumner	Stone (crushed).
Union	Do.
Union	Lime, stone (crushed).
Van Buren	Stone (crushed).
Warren	Do.
Washington	Clays, stone (crushed).
Weakley	Clays.
White	Stone (crushed).
Williamson	Phosphate rock, stone (crushed).
Wilson	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Tennessee business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population-----	thousands	4,729	4,767	4,803
Total civilian labor force-----	do-----	2,220	2,257	2,301
Unemployment-----	percent-----	8.6	8.0	8.0
<b>Employment (nonagricultural):</b>				
Mining total-----	thousands	8.0	7.7	7.5
Metal mining <sup>1</sup> -----	do-----	1.1	.9	.8
Nonmetallic minerals except fuels <sup>1</sup> -----	do-----	3.1	3.2	3.0
Coal mining <sup>1</sup> -----	do-----	3.0	2.9	2.7
Oil and gas extraction <sup>1</sup> -----	do-----	.6	.4	.4
Manufacturing total-----	do-----	497.1	492.4	491.3
Primary metal industries-----	do-----	16.2	16.8	16.2
Stone, clay, and glass products-----	do-----	14.3	14.3	14.4
Chemicals and allied products-----	do-----	41.5	40.0	38.7
Petroleum and coal products-----	do-----	.7	.8	.9
Construction-----	do-----	78.3	85.6	90.0
Transportation and public utilities-----	do-----	89.1	93.0	96.7
Wholesale and retail trade-----	do-----	413.3	435.3	450.3
Finance, insurance, real estate-----	do-----	85.9	89.4	93.8
Services-----	do-----	344.3	360.2	384.6
Government and government enterprises-----	do-----	296.1	304.2	314.0
Total-----	do-----	<sup>2</sup> 1,812.0	1,867.8	1,928.7
<b>Personal income:</b>				
Total-----	millions	\$50,289	\$53,793	\$57,645
Per capita-----	do-----	\$10,635	\$11,284	\$12,002
<b>Hours and earnings:</b>				
Total average weekly hours, production workers-----	do-----	40.9	41.0	41.2
Total average hourly earnings, production workers-----	do-----	\$7.9	\$8.3	\$8.6
<b>Earnings by industry:<sup>3</sup></b>				
Farm income-----	millions	\$795	\$691	\$601
Nonfarm-----	do-----	\$37,462	\$40,305	\$43,462
Mining total-----	do-----	\$260	\$290	\$286
Metal mining-----	do-----	\$26	\$29	\$34
Nonmetallic minerals except fuels-----	do-----	\$66	\$72	\$66
Coal mining-----	do-----	\$110	\$112	\$105
Oil and gas extraction-----	do-----	\$59	\$78	\$80
Manufacturing total-----	do-----	\$10,367	\$10,734	\$11,229
Primary metal industries-----	do-----	\$496	\$478	\$508
Stone, clay, and glass products-----	do-----	\$371	\$389	\$413
Chemicals and allied products-----	do-----	\$1,275	\$1,315	\$1,311
Petroleum and coal products-----	do-----	\$27	\$25	\$27
Construction-----	do-----	\$2,267	\$2,517	\$2,841
Transportation and public utilities-----	do-----	\$2,673	\$2,839	\$3,050
Wholesale and retail trade-----	do-----	\$6,553	\$7,114	\$7,672
Finance, insurance, real estate-----	do-----	\$1,896	\$2,105	\$2,435
Services-----	do-----	\$7,519	\$8,231	\$9,209
Government and government enterprises-----	do-----	\$5,779	\$6,245	\$6,584
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----	do-----	37,085	38,126	34,356
Value of nonresidential construction <sup>4</sup> -----	millions	\$839.8	\$1,352.4	\$1,284.9
Value of State road contract awards <sup>5</sup> -----	do-----	\$415.0	\$310.0	\$355.0
Shipments of portland and masonry cement to and within the State-----	thousand short tons	1,513	1,634	1,839
<b>Nonfuel mineral production value:</b>				
Total crude mineral value-----	millions	\$478.3	\$472.8	\$481.7
Value per capita-----	do-----	\$101	\$99	\$100

<sup>P</sup>Preliminary. <sup>T</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data do not add to total shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

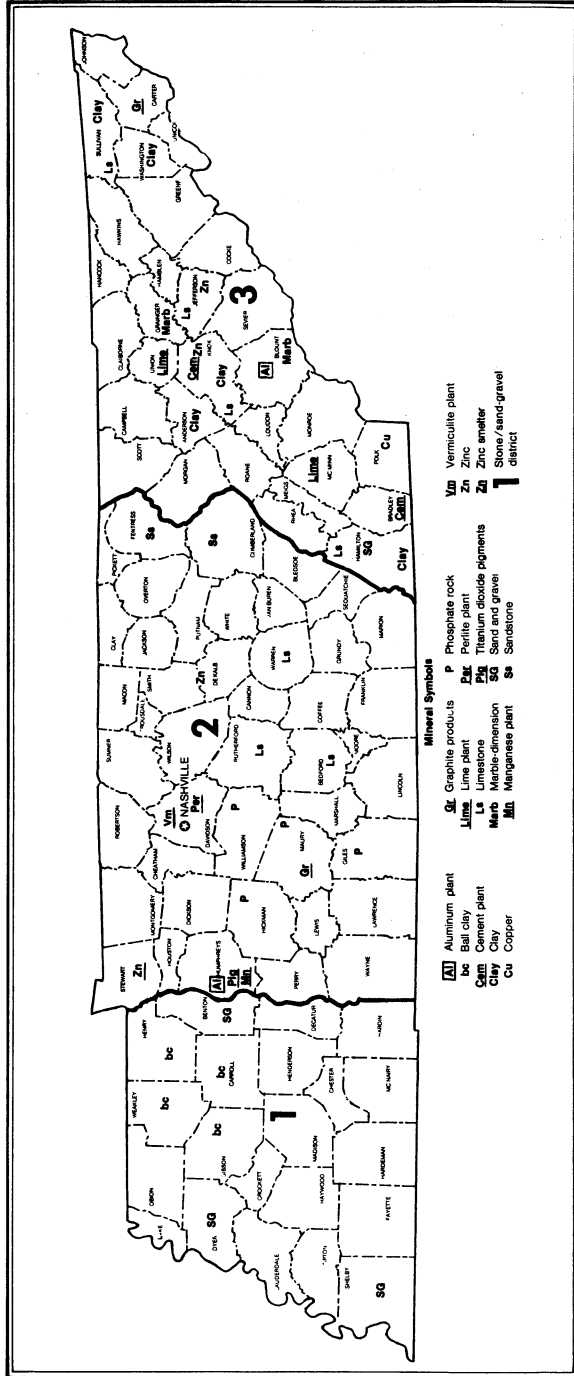


Figure 1.—Principal mineral-producing localities in Tennessee.

**Trends and Developments.**—Historically, over 50% of the State's mineral value has been derived from the sale of construction mineral commodities—clays, construction sand and gravel, and crushed stone. Tennessee's construction industry experienced a mixed year in 1986; single-family building permits rose 27% over the number issued in 1985, while the number of multifamily building permits fell 33%. The value of nonresidential construction rose a modest 3%.<sup>3</sup> An overbuilt office market and tax law changes that make commercial real estate investment less attractive were contributing factors.

Although the fluctuations in the various building sectors slowed the industry's requirements for construction raw materials, construction activity remained strong enough to require approximately 4 million short tons of construction mineral commodities over the level produced in 1985.

In April, groundbreaking for General Motors Corp.'s much-publicized Saturn automobile plant in Spring Hill took place. The construction industry and construction raw material suppliers in south-central Tennessee were principal beneficiaries during

the initial stages of construction for the \$3.5 billion facility.

**Legislation and Government Programs.**—Bills were introduced in both houses of the Tennessee Legislature that would allow the surface owner to obtain mineral rights under his or her property if "minerals have not been developed for 20 years, taxes paid, and no one comes forward within two years to register a claim" (House bill 1589).<sup>4</sup> At the final meeting of the 1986 session, the House Conservation Committee subcommittee considering the bill voted to delay it until the 1987 session.<sup>5</sup>

The Tennessee Geological Survey (TGS) officially operated as the Division of Geology of the Tennessee Department of Conservation and functioned as staff for the State Oil and Gas Board. During 1986, TGS's program of geologic mapping at the 1:24,000 scale continued, with 9 quadrangles published and 10 mapping projects in progress at yearend. A ground water study in the northern Cumberland Plateau, ongoing in 1985 in conjunction with the U.S. Geological Survey (USGS) and several oil and gas companies, was terminated by USGS because of budget constraints.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

Industrial minerals production accounted for 81% of the value of Tennessee mineral production in 1986, a 3% increase over the previous year. The reasons behind this increase were twofold: Metal production declined, and the output of construction sand and gravel and crushed stone increased.

**Barite.**—A Loudon County firm, A. J. Smith Co., was Tennessee's sole barite pro-

ducer in 1986. The company produced barite from an open pit operation in the southeastern part of the State.

**Cement.**—Tennessee's cement industry was composed of two companies with operations in the eastern part of the State.

Dixie Cement Co. Inc. is a subsidiary of Moore McCormack Cement Inc., and Signal Mountain Cement Co. is owned by IFI International.

Table 4.—Tennessee: Cement industry, 1986

Company	Location	Process	Number of kilns	Annual clinker capacity (thousand short tons)
Dixie Cement Co. Inc. -----	Knoxville -----	Dry -----	2	550
Signal Mountain Cement Co. ---	Chattanooga -----	Wet -----	2	450

**Clays.**—Tennessee's 8 clay producers operated 26 mines in 5 eastern and 4 western counties. Ball clay and fuller's earth were produced in the western part of the State, and common clay and shale were mined in the east.

Ball clay production was from a four-contiguous-county area: Carroll, Gibson, Henry, and Weakley. Ball clay was mined by surface methods and trucked to processing plants where it was shredded, dried, and pulverized. Clay shipments were (1) dried and shredded, (2) dried and pulverized, and (3) in slurry form. Three of the four producers had slurry shipment capability.

Common clay and/or shale was produced in Anderson-Knox, Hamilton, and Sullivan-Washington Counties in the eastern part of the State and in Henry County in western Tennessee. Production fell below that of 1985 by 30,000 short tons. Over 78% of the output was used in the manufacture of brick.

The remainder was used in pipe and tile manufacture.

One firm, Lowe's Inc., produced fuller's earth from an open pit operation in Henry County. After shredding, drying, sizing, and bagging, it was marketed as an absorbent for pet and industrial waste and as an insecticide and fungicide carrier.

**Gem Stones.**—Tennessee ranked second nationally in the value of natural gem materials produced. Freshwater pearls from the Tennessee River accounted for much of the value. The pearls were recovered during the harvesting of mussels for their shells. Shell material was used as a nucleus for pearl growth in the cultured pearl industry; much of the State's shell output was exported to Japan.

**Graphite (Synthetic).**—During 1986, the synthetic graphite industry consisted of two companies operating two plants. Pertinent data on the industry were as follows:

Company	City	County	Principal product
Great Lakes Carbon Corp. ----	Rockwood -----	Roane -----	High-modulus graphite fibers.
Union Carbide Corp. -----	Columbia -----	Maury -----	Electric-furnace electrodes.

Operations at Union Carbide Corp.'s plant at Clarksville, suspended in 1985 because of the depressed electrode market, remained suspended throughout 1986.

**Lime.**—Two companies, Tenn-Luttrell Lime Co. (a subsidiary of Penn-Virginia Corp. and Bowater Southern Paper Corp.) comprised the lime industry in Tennessee. Tenn-Luttrell operated an 800-short-ton-per-day lime plant at Luttrell near Knoxville, and Bowater produced lime to be used in papermaking. The paper, steel, and water purification industries provided the principal markets.

**Lithium.**—Organolithium compounds were produced at a Foote Mineral Co. plant at New Johnsonville. Both lithium carbonate and lithium metal plant feed were obtained from Foote operations at Kings Mountain, NC, and Silver Peak, NV. The New Johnsonville facility produced a variety of compounds including those used in lubricants, pharmaceuticals, and rubber manufacture.

**Magnesia (Fused).**—Tennessee Electro-minerals, a subsidiary of C-E Minerals Inc., produced fused magnesia at a plant in Greeneville. Fused silica was also produced at the facility. The operation produced both refractory grades of magnesia as well as multiple grades of electrical magnesia.

**Perlite (Expanded).**—Crude perlite was

shipped to Nashville from New Mexico and expanded at a Chemrock Corp. plant. The expanded material was sold for horticultural uses, construction applications, and as a filter medium.

**Phosphate Rock.**—Tennessee ranked fourth in phosphate rock output, behind Florida, North Carolina, and Idaho. Two companies, Occidental Chemical Corp. in Columbia and Stauffer Chemical Co. in Mount Pleasant, converted phosphate rock, mined by surface method under contract, into elemental phosphorus. In October, a third company, Monsanto Co., terminated operations and dismantled its plant. Approximately 400 positions were lost with the closure.

**Pyrites.**—Tennessee Chemical mined and processed pyrite in the Ducktown Basin in the southeastern part of the State. The company's surface and underground mines, between Ducktown and Copperhill, produced the raw material used to make sulfuric acid and liquid sulfur dioxide. Byproducts included blister copper, magnetite, and zinc concentrates. The company's chemical manufacturing facility was at Copperhill. The mines were scheduled to close in the third quarter of 1987, directly affecting approximately 800 jobs.

**Sand and Gravel.**—Construction.—Construction sand and gravel production is

surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The State's 43 construction sand and gravel companies operated 54 pits to produce 7.4 million short tons of sand and gravel valued at \$24.6 million. Tennessee ranked 39th in sand and gravel output. Six

of the top 10 producing counties were in the western part of the State and produced 65% of the total. The remaining four counties accounted for 13% of the total.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 6 presents end-use data for construction sand and gravel in Tennessee as depicted in figure 1.

**Table 5.—Tennessee: Construction sand and gravel sold or used by producers in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,946	\$7,445	\$3.83
Plaster and gunita sands -----	W	W	4.69
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	224	805	3.59
Asphaltic concrete aggregates and other bituminous mixtures -----	690	3,420	4.96
Road base and coverings -----	1,314	3,661	2.79
Fill -----	276	736	2.67
Snow and ice control -----	W	W	6.86
Roofing granules -----	174	984	5.37
Other <sup>1</sup> -----	65	311	4.78
Other unspecified <sup>2</sup> -----	2,671	7,279	2.73
Total or average -----	7,360	\$24,592	3.34

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

<sup>1</sup>Includes roofing granules and data indicated by symbol W.

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data do not add to total shown because of independent rounding.

**Table 6.—Tennessee: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	1,622	5,257	W	W	W	W
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	1,248	2,613	W	W	W	W
Other unspecified <sup>3</sup> -----	1,885	4,864	2,114	9,493	492	2,364
Total -----	4,755	12,734	2,114	9,493	492	2,364

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

<sup>1</sup>Includes plaster and gunita sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road base and coverings.

<sup>3</sup>Includes fill, snow and ice control, roofing granules, other specified uses, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

**Industrial.**—Three companies operated four pits in Benton, Campbell, Carroll, and Henry Counties to produce 488,000 short tons of industrial sand valued at \$5.5 million. Primary sales, in descending tonnages, were to the container, mold and core, blasting, filtration, and traction markets.

**Silica (Fused).**—Tennessee Electrominerals, a subsidiary of C-E Minerals, produced silica and fused magnesia at a plant in Greeneville. High-purity sand was fused

into ingots, which were cleaned, crushed, and processed into several grain and powder sizes for the extender, filler, foundry, and refractory markets.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—The estimated production of

crushed stone exceeded the 1985 reported figure by almost 2.8 million short tons. This equated to an increase in the market value of almost \$19.9 million.

**Dimension.**—In 1985, the last year that dimension stone producers were canvassed, Tennessee's dimension stone industry consisted of six companies operating six quarries in four counties in the eastern part of the State. Value fell approximately \$3 million.

**Vermiculite (Exfoliated).**—W. R. Grace & Co. shipped crude vermiculite from its operation in South Carolina to its construction products division in Nashville. The raw vermiculite was exfoliated and sold to insulation producers.

### METALS

The year proved to have been one of mixed productivity for the State's metals producers and/or processors. The base metals sector of the extractive metals industry, copper and zinc, witnessed a decrease in output, while one aluminum producer terminated production. Secondary smelters and refiners, however, viewed 1986 as a productive year.

**Aluminum.**—In January, Tennessee's

two aluminum producers, the Aluminum Co. of America at Alcoa and Consolidated Aluminum Corp. at New Johnsonville, were operating at 75% and 12%, respectively, of rated capacity. These two producers represented 7% of the Nation's ingot-producing capacity. At yearend, Alcoa had raised production to 94% and Consolidated had terminated operations. The closing was due, in part, to the weak aluminum market and high power rates.

**Copper.**—Tennessee Chemical continued as the only primary copper producer in the Southeastern United States. However, the company planned to phase out its underground and surface mine and mill in 1987 and to produce chemicals and sulfuric acid using purchased materials. Tennessee Chemical's operations were in the Ducktown-Copperhill area of southeastern Tennessee.

**Ferroalloys.**—Tennessee's ferroalloy industry was composed of four companies producing a variety of ferrophosphorus, ferrosilicon, and specialty silicon alloys.

In October, Monsanto, a ferrophosphorus producer, closed its operation at Columbia. The plant was dismantled.

Table 7.—Tennessee: Ferroalloy producers, 1986

Company	Plant location	Alloy
International Minerals & Chemical Corp	Kimball	Ferrosilicon and specialty silicon alloys.
Monsanto Co	Columbia	Ferrophosphorus.
Occidental Petroleum Corp	do	Do.
Stauffer Chemical Co	Mount Pleasant	Do.

**Germanium.**—Germanium residues from zinc smelting at Jersey Minière Zinc Co.'s Clarksville smelter were shipped to Belgium for refining. Metallurgie Hoboken-Overpelt S.A. was the refiner. Most of the concentrates were obtained from ore from the company's central Tennessee mines.

**Iron and Steel.**—Knoxville Iron Co., Knoxville, was the State's only iron producer. During the year, the company completed a \$15 million expansion, which included a new rolling mill and a 50-short-ton electric furnace.

**Lead.**—Three companies recovered lead from scrap, primarily from automobile batteries. These companies are noted in the

following tabulation.

Company	Location
General Smelting & Refinery Co.	College Grove.
Refined Metals Corp	Memphis.
Ross Metals Inc	Rossville.

**Manganese.**—Foote produced electrolytic manganese dioxide at a 10,000-short-ton-per-year plant at New Johnsonville in central Tennessee. The material was used in alkaline batteries.

**Nickel.**—Activated Metals and Chemicals Inc. produced nickel alloys and metal catalysts at a plant in Sevierville.

**Platinum.**—The Platinum Group Metals Div. of National Refining Corp. operated a precious metals scrap refinery at Gallatin. Scrap was obtained from the chemical, petrochemical, petroleum, and pharmaceutical industries.

**Rare Earths and Thorium.**—Davison Chemical Div. (a subsidiary of W. R. Grace) operated a rare-earth and thorium plant at Chattanooga. Davison imported monazite from Australia and Malaysia to produce rare-earth chlorides, fluorides, and oxides, as well as cerium oxides and compounds. Davison was scheduled to expand its separation plant using technology licensed from Shin-Etsu Chemical Co. Ltd.<sup>4</sup>

**Uranium.**—Martin Marietta Energy System Inc. machined uranium-forged billets into rounded parts at a plant at Oak Ridge. The parts were used in the fabrication of nuclear weapons.

**Zinc.**—The State again led the Nation in the production of zinc, despite a decline in output for the second straight year. Two companies operated five mines in eastern Tennessee, and one company operated two mines in central Tennessee. Mining was by underground method, and flotation was

used to recover a zinc concentrate. A 90,000-short-ton-per-year zinc refinery was in Clarksville, northwest of Nashville. Concentrate was moved to the refinery by truck and barge.

The zinc industry operated at reduced levels for several months as falling prices and foreign imports continued to depress the demand for domestic zinc. In February, ASARCO Incorporated closed the New Market Mine and mill, affecting approximately 133 employees. In April, the company closed its remaining three zinc mines in eastern Tennessee, affecting 300 additional employees. The three mines were reopened in June as zinc prices improved to some extent. However, the New Market operation remained closed until mid-September.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Tuscaloosa, AL.

<sup>2</sup>Geologist, Tennessee Division of Geology, Knoxville, TN.

<sup>3</sup>Economic Review. The Southeast in 1987. Nov.-Dec. 1986, p. 43.

<sup>4</sup>Johnson City Press-Chronicle. Bill Deals With Mineral Rights Puzzle. Mar. 9, 1986.

<sup>5</sup>Knoxville News Sentinel. House Kills Minerals-Rights Law Changes. Mar. 12, 1986.

<sup>6</sup>Rare-Earth Information Center News. Grace To Separate Rare Earths. V. 21, No. 3, Sept. 1, 1986, p. 2.

**Table 8.—Tennessee: Mine production (recoverable) of copper, lead, silver, and zinc**

	1984	1985	1986
Mines producing: Lode	8	9	7
Ore sold or treated:			
Copper-zinc	thousand metric tons	W	W
Zinc	do.	W	W
Total <sup>1</sup>	do.	6,071	5,374
Production:			
Quantity:			
Copper	metric tons	W	W
Lead	do.	W	W
Silver	troy ounces	W	W
Zinc	metric tons	116,526	104,471
Value:			
Copper	thousands	W	W
Lead	do.	W	W
Silver	do.	W	W
Zinc	do.	\$124,854	\$92,971
			\$85,550

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Includes data indicated by symbol W.

**Table 9.—Tennessee: Zinc industry, 1986**

Company	Mine	Mill
ASARCO Incorporated	Coy	Mascot.
Do	Immel	Do.
Do	New Market	New Market.
Do	Young	Mascot.
Inspiration Resources Corp	Beaver Creek	Jefferson City.
Jersey Minière Zinc Co	Elmwood	Elmwood.
Do	Gordonsville	Do.
USX Corp	Jefferson City	Jefferson City.



**Table 10.—Tennessee: Tenor of zinc ore milled and concentrates produced**

	1985	1986	
Total material .....	metric tons ..	5,373,817	5,180,024
Metal content of ore: <sup>1</sup> Zinc .....	percent ..	2.02	2.06
Concentrates produced and average content:			
Zinc concentrate .....	metric tons ..	172,027	167,822
Average zinc content .....	percent ..	63.25	63.51

<sup>1</sup>Figures represent metal content of crude ore only as contained in the concentrate.

**Table 11.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Aluminum smelters:</b>			
Aluminum Co. of America .....	Box 158 Alcoa, TN 37701	Plant .....	Blount.
Consolidated Aluminum Corp ..	1102 Richmond St. Jackson, TN 38301	....do .....	Humphreys.
<b>Barite:</b>			
A. J. Smith Co .....	Route 3 Sweetwater, TN 37874	Open pit mine .....	Loudon.
<b>Cement:</b>			
Dixie Cement Co. Inc., <sup>1 2</sup> a subsidiary of Moore McCormack Cement Inc.	Box 14009 Knoxville, TN 37914	Plant .....	Knox.
Signal Mountain Cement Co ..	1300 American National Bank Bldg. Chattanooga, TN 37402	....do .....	Hamilton.
<b>Clays:</b>			
Cyprus Industrial Minerals Co ..	Box 111 Gleason, TN 38229	Pits and plants .....	Carroll and Weakley.
General Shale Products Corp ..	Box 3547 CRS Johnson City, TN 37601	....do .....	Anderson, Hamilton, Knox, Sullivan, Washington.
Kentucky-Tennessee Clay Co ..	Box 449 Mayfield, KY 42066	....do .....	Carroll, Gibson, Henry, Weakley.
Lowe's Inc .....	Box 819 Paris, TN 38242	....do .....	Henry.
Old Hickory Clay Co .....	Box 188 Gleason, TN 38229	....do .....	Henry and Weakley.
H. C. Spinks Clay Co. Inc .....	Box 820 Paris, TN 38229	....do .....	Carroll, Henry, Weakley.
<b>Copper:</b>			
Tennessee Chemical Co. <sup>3</sup> .....	Copperhill, TN 37317 ..	Underground mines, surface mine, plant.	Polk.
<b>Graphite (synthetic):</b>			
Great Lakes Carbon Corp .....	Box 1301 Rockwood, TN 37643	Plant .....	Roane.
Union Carbide Corp .....	Box 513 Columbia, TN 38401	....do .....	Maury.
<b>Lime:</b>			
Bowater Southern Paper Corp ..	Calhoun, TN 37309 .....	....do .....	McMinn.
Tenn-Luttrell Lime Co. ....	Box 69 Luttrell, TN 37779	....do .....	Union.
<b>Perlite (expanded):</b>			
Chemrock Corp .....	Osage St. Nashville, TN 37208	....do .....	Davidson.
<b>Phosphate rock:</b>			
Occidental Chemical Corp. <sup>4</sup> .....	Box 591 Columbia, TN 38401	....do .....	Do.
Stauffer Chemical Co. <sup>4</sup> .....	Box 89 Mount Pleasant, TN 38474	....do .....	Do.
<b>Sand and gravel:</b>			
Dixie Sand & Gravel Co .....	515 River St. Chattanooga, TN 37402	Pits .....	Hamilton.
Memphis Stone & Gravel Co ..	Box 1683 Memphis, TN 38101	....do .....	Benton, Dyer, Shelby.
Rogers Group Inc. <sup>2</sup> .....	Box 25250 Nashville, TN 37202	....do .....	Tipton.
Standard Construction Co. Inc ..	Box 38289 Germantown, TN 38138	Pit .....	Shelby.

See footnotes at end of table.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Stone (1985):</b>			
<b>Limestone:</b>			
American Limestone Co ----	180 Maiden Lane New York, NY 10038	Quarries -----	Jefferson, Knox, Sullivan,
Hoover Inc -----	Box 17346 Nashville, TN 37217	---do-----	Bedford, Hamilton, Rutherford, Warren.
Vulcan Materials Co -----	Box 7497 Birmingham, AL 35253	---do-----	Do.
<b>Marble:</b>			
John J. Craig Co -----	Box 9300 Knoxville, TN 37920	Quarry -----	Blount.
Imperial Black Marble Corp.	8013 Chesterfield Dr. Knoxville, TN 37919	---do-----	Grainger.
<b>Sandstone:</b>			
Ross L. Brown Cut Stone Co. Inc.	Box 398 Crab Orchard, TN 37723	---do-----	Cumberland.
Crab Orchard Stone Co. Inc	Drawer J Crossville, TN 38555	---do-----	Do.
Crossville Limestone Co. Inc	Box 485 Crossville, TN 38555	---do-----	Do.
Mountain Stone Co -----	Box 246 Jamestown, TN 38556	---do-----	Fentress.
<b>Vermiculite (exfoliated):</b>			
W. R. Grace & Co -----	4061 Powell Ave. Nashville, TN 37204	Plant -----	Davidson.
<b>Zinc:</b>			
ASARCO Incorporated <sup>2</sup> -----	Mascot, TN 37806 ----	Underground mines and plant.	Jefferson and Knox.
Inspiration Resources Corp -----	Box 32 Jefferson City, TN 37760	Underground mine and plant.	Jefferson.
Jersey Minière Zinc Co -----	Elmwood, TN 38560 ---	Underground mines, plant, smelter.	Smith.
USX Corp. <sup>2</sup> -----	Jefferson City, TN 37760	Underground mine	Jefferson.

<sup>1</sup>Also clays.<sup>2</sup>Also stone.<sup>3</sup>Also pyrites, silver, and zinc.<sup>4</sup>Also ferroalloys.



# The Mineral Industry of Texas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, The University of Texas at Austin, for collecting information on all nonfuel minerals.

By Jane P. Ohl<sup>1</sup> and Mary W. McBride<sup>2</sup>

Total value of nonfuel minerals produced in Texas in 1986 was \$1.7 billion, an insignificant decrease from that of 1985; the State again ranked second in the Nation.

In 1986, 19 nonfuel minerals were produced in the State, 17 industrial minerals and 2 metals (iron ore and magnesium

metal). Texas again was the Nation's leading producer of native asphalt, crude gypsum, magnesium metal, crushed stone, and Frasch sulfur. The State ranked second in output of portland cement, calcined gypsum, crude and Grade-A helium, construction sand and gravel, and talc.

Table 1.—Nonfuel mineral production in Texas<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:						
Masonry ----- thousand short tons..	291	\$24,409	263	\$22,114	209	\$15,790
Portland ----- do.....	10,423	557,421	10,242	532,494	8,883	412,697
Clays ----- do.....	<sup>2</sup> 3,517	<sup>2</sup> 17,091	4,107	28,059	<sup>2</sup> 2,515	<sup>2</sup> 11,724
Gem stones ----- do.....	NA	<sup>4</sup> 175	NA	<sup>4</sup> 175	NA	297
Gypsum ----- thousand short tons..	2,166	19,431	1,981	17,299	2,131	14,982
Lime ----- do.....	1,157	61,214	1,192	65,927	1,173	62,670
Salt ----- do.....	8,184	69,672	8,390	<sup>3</sup> 84,249	8,520	62,996
Sand and gravel:						
Construction ----- do.....	62,389	199,461	<sup>5</sup> 57,800	<sup>5</sup> 198,000	59,562	209,855
Industrial ----- do.....	2,028	29,282	1,968	29,095	1,302	18,274
Stone:						
Crushed ----- do.....	<sup>6</sup> 89,200	<sup>6</sup> 300,000	85,764	306,821	<sup>6</sup> 84,200	<sup>6</sup> 301,500
Dimension ----- do.....	<sup>r</sup> <sup>4</sup> 6	<sup>r</sup> <sup>4</sup> 14,374	<sup>r</sup> <sup>3</sup> 6	<sup>r</sup> <sup>1</sup> 11,209	<sup>4</sup> 9	<sup>4</sup> 15,407
Sulfur (Frasch) -- thousand metric tons..	2,994	W	2,979	W	2,506	W
Talc ----- thousand short tons..	240	4,125	261	5,245	283	6,456
Combined value of asphalt (native), clays (ball clay, 1986, fuller's earth and kaolin, 1984, 1986), fluorspar, helium (crude and Grade-A), iron ore (usable), magnesium chloride <sup>3</sup> (1984-85), magnesium compounds, magnesium metal <sup>4</sup> (1986), mica (scrap, 1984-85), sodium sulfate (natural), and values indicated by symbol W -----	XX	419,861	XX	435,936	XX	579,340
Total -----	XX	<sup>r</sup> 1,716,516	XX	<sup>r</sup> 1,736,623	XX	1,711,988

<sup>6</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes ball clay (1986), fuller's earth, and kaolin; value included with "Combined value" figure.

<sup>3</sup>Magnesium chloride for magnesium metal reporting was discontinued in 1986.

<sup>4</sup>Magnesium metal (refinery production) not reported in 1984 and 1985.

Table 2.—Nonfuel minerals produced in Texas in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Andrews	Stone (crushed).
Atascosa	Sand (industrial).
Bandera	Stone (crushed).
Bastrop	Clays.
Bee	Stone (crushed).
Bell	Do.
Bexar	Cement, stone (crushed), clays.
Bosque	Stone (crushed).
Brazoria	Magnesium chloride, salt, magnesium compounds.
Brewster	Fluorspar.
Brown	Stone (crushed).
Burleson	Do.
Burnet	Stone (crushed), stone (dimension).
Cass	Iron ore.
Chambers	Salt, clays.
Cherokee	Iron ore, clays.
Coleman	Clays.
Collin	Stone (crushed).
Collingsworth	Do.
Colorado	Sand (industrial).
Comal	Cement, stone (crushed).
Comanche	Clays.
Concho	Stone (crushed).
Cooke	Do.
Coryell	Do.
Culberson	Sulfur, talc, stone (crushed), mica.
Dallas	Cement, stone (crushed), clays.
Deaf Smith	Stone (crushed).
Denton	Clays.
Donley	Stone (crushed).
Duval	Stone (crushed), salt.
Eastland	Clays, stone (crushed).
Ector	Cement, stone (crushed), salt.
Ellis	Cement, stone (crushed), clays.
El Paso	Cement, stone (crushed).
Fayette	Clays.
Fisher	Do.
Floyd	Stone (crushed).
Fort Bend	Salt, stone (crushed), clays.
Freestone	Stone (crushed).
Gaines	Sodium sulfate, stone (crushed).
Gillespie	Gypsum, stone (dimension), stone (crushed).
Gonzales	Clays.
Grayson	Stone (crushed).
Guadalupe	Clays.
Hale	Stone (crushed).
Hansford	Do.
Hardeman	Gypsum.
Hardin	Sand (industrial).
Harris	Cement, sand (industrial), salt, clays.
Harrison	Clays.
Hays	Cement, stone (crushed).
Henderson	Clays.
Hidalgo	Stone (crushed).
Hill	Lime, stone (crushed).
Hood	Stone (crushed).
Hudspeth	Talc, stone (crushed), gypsum.
Hutchinson	Stone (crushed).
Jack	Do.
Jasper	Do.
Jefferson	Salt.
Jim Wells	Stone (crushed).
Johnson	Sand (industrial), stone (crushed).
Kaufman	Stone (crushed).
Kimble	Gypsum.
Lamb	Stone (crushed).
Lampasas	Do.
Liberty	Sand (industrial).
Limestone	Stone (crushed), clays, sand (industrial).
Live Oak	Sand (industrial), stone (crushed).
Llano	Stone (crushed), stone (dimension).
Lubbock	Stone (crushed).
McCulloch	Sand (industrial).
McLennan	Cement, stone (crushed), clays.
McMullen	Stone (crushed).
Martin	Do.
Matagorda	Do.
Medina	Salt.
Midland	Clays.
Morris	Stone (crushed).
Motley	Do.
Nacogdoches	Do.
	Clays.

See footnote at end of table.

Table 2.—Nonfuel minerals produced in Texas in 1985, by county<sup>1</sup>—Continued

County	Minerals produced in order of value
Navarro	Stone (crushed), clays.
Newton	Sand (industrial).
Nolan	Cement, gypsum, stone (crushed), clays.
Nueces	Cement.
Orange	Do.
Palo Pinto	Clays.
Parker	Stone (crushed), clays.
Pecos	Sulfur.
Potter	Cement, stone (crushed), clays.
Randall	Stone (crushed).
Rusk	Clays.
San Patricio	Stone (crushed).
San Saba	Do.
Smith	Clays.
Somervell	Stone (dimension).
Stonewall	Gypsum.
Tarrant	Cement, stone (crushed).
Taylor	Stone (crushed).
Terry	Sodium sulfate.
Tom Green	Stone (crushed).
Travis	Do.
Uvalde	Do.
Val Verde	Do.
Van Zandt	Salt, clays.
Walker	Stone (crushed), clays.
Wharton	Sulfur.
Williamson	Stone (crushed), stone (dimension).
Wise	Stone (crushed), clays.
Wood	Clays.
Young	Stone (crushed).
Undistributed <sup>2</sup>	Sand and gravel (construction), asphalt (native), helium, gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Texas business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
Employment and labor force, annual average:				
Population	thousands	16,083	16,389	16,685
Total civilian labor force	do	7,913	8,080	8,159
Unemployment	percent	5.9	7.0	8.9
Employment (nonagricultural):				
Mining total	thousands	269.1	259.2	208.8
Nonmetallic minerals except fuels <sup>1</sup>	do	7.3	6.5	6.3
Oil and gas extraction	do	259.9	249.7	198.1
Manufacturing total	do	1,004.3	998.6	960.3
Primary metal industries	do	35.8	33.3	29.2
Stone, clay, and glass products	do	49.3	49.7	47.8
Chemicals and allied products	do	77.6	78.0	74.8
Petroleum and coal products	do	41.2	37.0	34.3
Construction	do	446.3	443.8	413.5
Transportation and public utilities	do	374.0	380.8	374.5
Wholesale and retail trade	do	1,640.8	1,699.0	1,684.5
Finance, insurance, real estate	do	419.8	445.9	447.8
Services	do	1,274.6	1,346.7	1,372.1
Government and government enterprises	do	1,063.5	1,088.9	1,119.0
Total	do	6,492.4	6,663.1	6,580.5
Personal income:				
Total	millions	\$205,529	\$221,052	\$224,877
Per capita		\$12,780	\$13,488	\$13,478
Hours and earnings:				
Total average weekly hours, production workers		41.7	41.2	41.4
Mining		46.5	43.8	42.4
Total average hourly earnings, production workers		\$9.0	\$9.4	\$9.7
Mining		\$10.3	\$11.0	\$12.0

See footnotes at end of table.

Table 3.—Indicators of Texas business activity —Continued

	1984 <sup>a</sup>	1985	1986 <sup>b</sup>	
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$2,514	\$2,636	\$2,540
Nonfarm -----	do.	\$157,350	\$168,418	\$169,272
Mining total -----	do.	\$10,134	\$10,306	\$8,709
Metal mining -----	do.	\$20	\$20	\$18
Nonmetallic minerals except fuels -----	do.	\$201	\$190	\$132
Coal mining -----	do.	\$60	\$65	\$195
Oil and gas extraction -----	do.	\$9,554	\$1,030	\$8,964
Manufacturing total -----	do.	\$26,379	\$27,701	\$27,193
Primary metal industries -----	do.	\$1,121	\$1,011	\$913
Stone, clay, and glass products -----	do.	\$1,152	\$1,204	\$1,208
Chemicals and allied products -----	do.	\$2,923	\$3,104	\$3,122
Petroleum and coal products -----	do.	\$2,072	\$1,950	\$1,797
Construction -----	do.	\$14,254	\$14,581	\$14,096
Transportation and public utilities -----	do.	\$11,942	\$12,790	\$12,927
Wholesale and retail trade -----	do.	\$28,730	\$30,486	\$30,529
Finance, insurance, real estate -----	do.	\$10,714	\$11,828	\$12,525
Services -----	do.	\$31,361	\$34,535	\$36,149
Government and government enterprises -----	do.	\$23,085	\$25,399	\$26,351
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		195,509	143,114	96,737
Value of nonresidential construction <sup>4</sup> -----	millions	\$7,816.8	\$7,419.6	\$5,262.2
Value of State road contract awards <sup>5</sup> -----	do.	\$974.0	\$1,340.0	\$1,887.0
Shipments of portland and masonry cement to and within the State -----	thousand short tons	11,355	11,179	9,450
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$1,716.6	\$1,736.6	1,712.0
Value per capita -----	do.	\$107	\$106	\$108

<sup>a</sup>Preliminary. <sup>b</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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.**—Texas cement, gypsum, and lime facilities continued to appeal to foreign investors, and additional purchases of such facilities were made. Legislation to control inroads from foreign producers of crushed stone and oil was proposed.

The collapse in world oil prices that occurred in February dropped western Texas intermediate oil to about \$12 per barrel. The effects of falling oil prices were felt throughout the Texas economy, and a State economic recession occurred in 1986. However, some improvement in oil and gas drilling activity was seen by yearend.

As the petroleum industry activities declined, so did the consumption of drilling muds, which utilize cement and barite mined in Texas.

The Texas portland cement industry, second largest in the Nation, was affected by foreign imports of cheap clinker, and by yearend all Texas gulf coast plants had ceased to produce clinker.

Despite the generally poor economy, four Texas cities were among the Nation's fastest growing (1980-86): Dallas-Fort Worth metropolitan population was up 26%; San Antonio, 20%; and Houston, 17%; the construction industry and construction materi-

al producers benefited from the concomitant effects of population increases.

**Employment.**—Employment across the State and in almost every business sector was down from that of 1984-85.

**Environment.**—The U.S. Environmental Protection Agency issued its final rules on arsenic emissions from copper smelters and glass-manufacturing plants in July 1986. ASARCO Incorporated's El Paso copper smelter was among three plants required to install additional air-pollution control equipment to comply with the new emission standards.

**Exploration Activities.**—A Federal-State task force began assessing the resource potential of nonfuel minerals in the Gulf of Mexico. Initial investigations will concern sand and gravel and heavy-mineral sands.

**Legislation and Government Programs.**—The Houston sand and gravel and crushed stone market was reviewed by the U.S. Bureau of Mines as part of a larger study of sand and gravel deposits in the offshore U.S. Exclusive Economic Zone.

The Texas Supreme Court ruled in January that all minerals on any lands sold or conveyed by the State belonged to the State unless expressly conveyed. The case had specific application to a cannel coal deposit

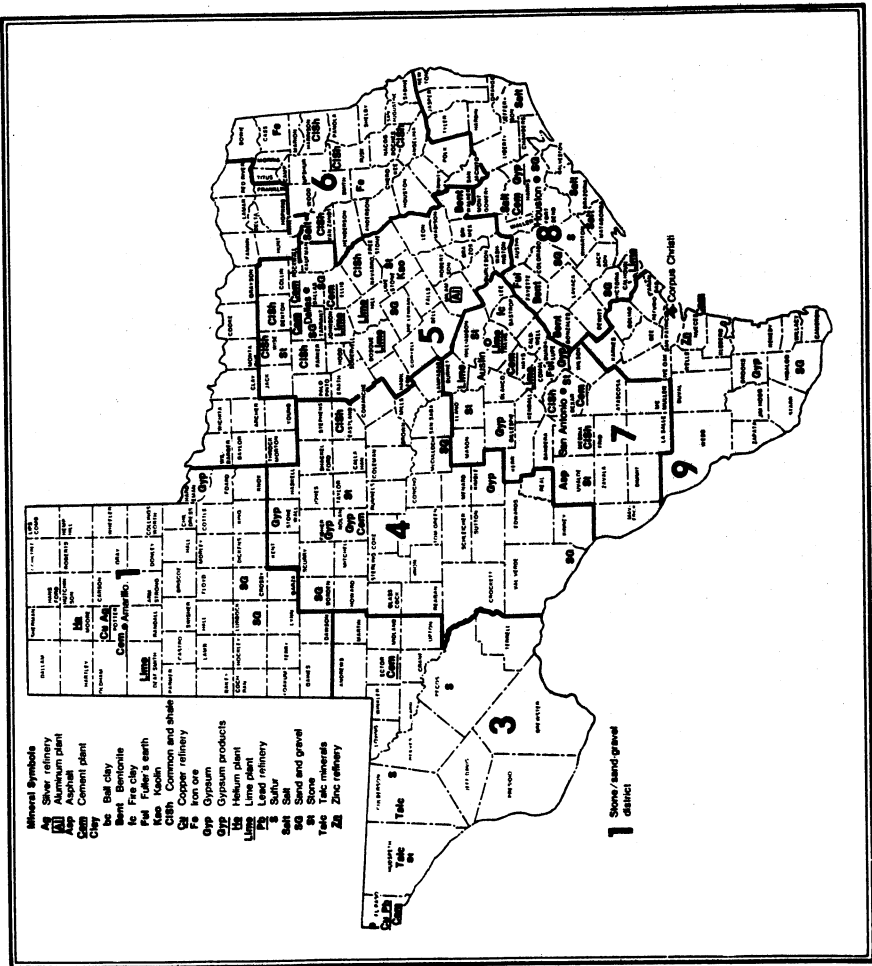


Figure 1.—Principal mineral-producing localities in Texas.



**near Laredo**, but State Land Office officials were concerned that a broad interpretation of the ruling might jeopardize revenues from other minerals on State-owned land.

The Texas Bureau of Economic Geology, using some funding from a U.S. Bureau of

Mines grant to the Texas Mining and Mineral Resources Research Institute, published two volumes on nonfuel minerals and a data base of producers of nonpetroleum minerals in the State.<sup>3</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Barite.**—Texas barite companies mined no barite, but substantial amounts of barite from out of State were ground in Texas for the oil-services industry.

The downturn in oil-drilling activities brought about changes in the oil-services industry: Newpark Resources Inc. and Milchem Inc. combined resources under the new name Milpark Inc. Halliburton Co. (IMCO Services Div.) and Dresser Industries Inc. (Magcobar Minerals Div.) formed a joint venture for their drilling fluids businesses, called M-I Drilling Fluids Co. Hughes Tool Co. and Baker International Corp. formed a joint holding company, Baker Hughes Inc. NL Industries Inc. (NL Baroid Muds) was purchased by an investor group but was still independent at yearend. Chromalloy American Corp. discontinued its drilling fluids division, including its Harris County operation, and many smaller Texas operators also discontinued services.

**Cement.**—Texas ranked second of 40 portland-cement-producing States. Caught in the fall of construction and oil drilling activities, output and value declined even more steeply than in 1985. Masonry cement output and value declined approximately one-fifth and one-quarter, respectively.

Floating silo ships, or oceangoing barges fitted with Siwertell unloaders, were being considered by some members of the Texas gulf coast cement industry as an efficient way to expand markets in other Gulf States.<sup>4</sup>

Reporting to the U.S. Bureau of Mines were 9 firms that operated 18 cement plants. Only 15 of these plants produced clinker and 12 produced masonry cement, according to the Texas Bureau of Economic Geology. The 9 firms operated 15 wet-process and 15 dry-process kilns. Five plants served as grinding and distribution terminals for either domestic or foreign imports. By yearend, only 14 clinkering plants were in the State. Beginning in 1987, seven plants that produced clinker as recently as 1983 will serve only as grinding and distribution centers of either domestic or foreign clinker.

Raw materials consumed were 7.7 million

short tons of limestone, 1.7 million tons of cement rock, 1.1 million tons of marl, 0.582 million tons of clinker, 0.562 million tons of clay, 0.329 million tons of sand, 0.222 million tons of shale, and smaller amounts of fly ash, gypsum, iron ore, mill scale, and various resins and chemicals.

The most significant carbonate cement resource rocks were the Austin Chalk and Edwards Limestone; argillaceous resources included the Eagle Ford Shale and Taylor Marl.

Price per short ton of finished portland cement dropped from \$51.99 to \$46.46. Shipments of gray finished portland cement, classified as general-use and moderate-heat type, high-early-strength, and very high sulfate resistance, also declined significantly, and sales of the oil well variety plummeted 52.8% in quantity, 58.7% in total value, and 12.5% in price.

In decreasing order of quantity, finished portland cement was sold to ready-mixed concrete companies (64.9% of shipments), building contractors, concrete product manufacturers, highway contractors, miscellaneous customers, building material dealers, and government agencies. Bulk shipments from plant to terminal were transported by rail (97% of shipments) and by truck. Some shipments between terminal and ultimate consumer were transported by barge.

Blue Circle West Inc. of Phoenix, AZ, and Cementos de Chihuahua of Mexico formed BlueCem (headquartered in El Paso but since closed) to operate a 500-ton-capacity import terminal in El Paso. The cement will be made at Blue Circle's plant in Mexico.

Box-Crow Cement Co. was completing its new 1-million-ton-per-year plant at Midlothian, Ellis County. The plant was expected to go on-line in April 1987.

Centex Cement Corp. (a subsidiary of Centex Corp.) and Lehigh Portland Cement Co. (a unit of Heidelberger Zement AG, Heidelberg, Federal Republic of Germany) agreed in March to jointly produce and market cement in Texas. Centex's Buda 1.1-million-ton-per-year gray cement plant and several terminals throughout the State, including one at Corpus Christi, were to be included in the joint operation. In addition, Lehigh's Waco plant was to sell specialty

cement products to the joint venture. Centex's ready-mixed concrete operation in Austin and its aggregate plant in northern Texas were not part of the agreement. Lehigh and Centex later announced a joint venture, named Texas Sunbelt Cement, with Cementos Mexicanos S.A. The new firm was to market imported cement in southern Texas.<sup>5</sup>

Gifford-Hill & Co. Inc. of Dallas agreed in September to be acquired by England's C. H. Beazer (Holdings) PLC (United Kingdom) sometime in early 1987. This was Beazer's first venture into the U.S. cement and aggregate industries.

**Table 4.—Texas: Masonry cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	12	12
Production	262,705	216,539
Shipments from mills:		
Quantity	263,198	209,244
Value	\$22,113,992	\$15,790,334
Stocks at mills, Dec. 31	26,012	27,542

**Table 5.—Texas: Portland cement salient statistics**

(Short tons unless otherwise specified)

	1985	1986
Number of active plants	18	18
Production	10,118,497	8,330,620
Shipments from mills:		
Quantity	10,242,074	8,883,021
Value	\$532,494,482	\$412,696,964
Stocks at mills, Dec. 31	588,782	516,582

Lafarge Corp., Dallas, announced at yearend that it had temporarily closed its Fort Worth cement plant because of a "severe decline in demand." Officials at General

Portland Inc., a Lafarge subsidiary, stated that the shutdown was part of an overall restructuring of its Texas supply system. The restructuring consisted of three additional stages: adaptation of the Fort Worth plant to distribute large volumes of cement received by rail from General Portland's New Braunfels plant, improvement of the capacity and cost competitiveness of the Dallas cement plant, and start of construction on a deepwater import terminal on the Houston Ship Channel.<sup>6</sup>

Also at yearend, Lafarge was in the process of acquiring control of National Gypsum Co.'s cement division.

Southwestern Portland Cement Co., a division of Southdown Inc., formed a joint venture company with Mexico's Cementos Mexicanos to market imported Cementos Mexicanos cement in the United States where Southwestern Portland had terminals or distribution facilities; one of these was at El Paso.<sup>7</sup>

Clays.—Clays decreased significantly in output and value from 1985 figures.

Mining of bentonitic ash deposits in Jeff Davis County was substantially enlarged by Basalt Industries of Pecos.<sup>8</sup>

Clay mining involved 27 companies, which operated 67 pits in 27 of 254 counties in Texas: 52 pits produced common clay and shale; 1 pit each, ball clay, fuller's earth, and kaolin; 3 pits, fire clay; and 9 pits, swelling or nonswelling bentonite. Six of the twenty-seven companies each produced more than 100,000 short tons of clays, totaling 1.9 million tons and \$8.5 million of combined clay values.

Values of Texas clays ranged widely but averaged \$8.28 per ton, a substantial increase over that of 1985.

**Table 6.—Texas: Clays sold or used by producers, by kind**

(Thousand short tons and thousand dollars)

Year	Ball clay, fuller's earth, kaolin		Bentonite		Fire clay		Common clay and shale		Total <sup>1</sup>	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1982	114	\$5,036	100	\$5,161	38	\$234	3,940	\$16,067	4,193	\$26,497
1983	123	4,985	75	2,876	44	288	3,714	14,427	3,955	22,575
1984	101	6,573	62	926	24	190	3,407	15,362	3,594	23,051
1985	120	8,736	47	850	21	156	3,919	18,318	4,107	28,059
1986	143	9,961	33	975	20	139	2,424	10,610	2,619	21,685

<sup>1</sup>Revised.

<sup>1</sup>Data may not add to totals shown because of independent rounding.

Fluorspar.—Crude fluorspar was shipped from Machaca Resources Inc.'s mine in Brewster County. In the past, the mine was operated by D & F Minerals Co.

Gypsum.—Imasco Ltd., a Canadian conglomerate, acquired Genstar Corp. in August. Genstar Gypsum Products Co., a subsidiary, operated a quarry and wallboard

plant at Sweetwater, Nolan County. Imasco later sold these facilities to Domtar Inc. of Montreal, Canada.

National Gypsum Co. was acquired by a wholly owned subsidiary of Aancor Holdings Inc., a corporation newly formed by the senior management of National Gypsum in a leveraged buyout that was completed on April 29, 1986.

Standard Gypsum Co., Houston, purchased about 200 million short tons of high-

grade gypsum reserves in Culberson County. An abandoned open pit mine already existed on the 12,500-acre site.

Lime.—Genstar Lime Co. (acquired by Imasco from Genstar Corp.) was sold to Chemical Lime Co. of Fort Worth and Lhoist Group of Belgium. Genstar Lime had no lime plants in Texas, but Chemical Lime had plants in Bosque and Burnet Counties. The sale was pending U.S. Government approval in November.

Table 7.—Texas: Lime sold or used by producers, by use

Use	1985		1986	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Road stabilization -----	455,754	\$27,033	341,371	\$18,476
Soil stabilization ----- W		W	334,384	18,820
Water purification -----	118,897	6,124	142,982	7,290
Steel, electric ----- W		W	115,939	5,587
Paper and pulp -----	42,443	1,968	44,151	2,241
Other <sup>1</sup> -----	575,323	30,802	194,594	10,256
Total -----	1,192,417	65,927	1,173,421	62,670

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

<sup>1</sup>Includes acid water neutralization, aluminum and bauxite, agriculture, basic oxygen furnace steel, finishing lime, food (animal and other), magnesium, mason's lime, oil well drilling, open-hearth steel, other chemical and industrial uses, petroleum refining, sewage treatment, sugar refining, and data indicated by symbol W.

**Magnesium Compounds.**—The Dow Chemical Co. produced less magnesium compounds from its seawater operation in Brazoria County, but unit price rose about \$7.50 per short ton above that of 1985.

**Salt.**—Salt output reported by seven companies from nine Texas counties increased slightly over that of 1985. Total value and price per short ton, however, fell by about one-quarter. Dow Chemical's facility at Brazoria County was the State's largest salt producer.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Although output and total value fluctuated during the 1984-86 period, price per short ton of construction sand and gravel continued to increase, but at a declining rate, and was \$0.41 above the national average. Of the State's 254 counties, 78 produced construction sand and gravel from 236 pits. Texas Industries Inc., which had operations in five counties—Dallas, Ellis, Parker, Travis, and Wise—was the State's first-ranking producer. The other 176 producing companies had operations in one to four counties each. Texas ranked second in

the Nation in construction sand and gravel produced in 1986.

In descending order of value of output, construction sand and gravel was used for concrete aggregates, asphaltic concrete aggregates, road base and coverings, fill, plaster and gunite sands, and concrete products. Slightly more than 56% of production was transported by truck; 36% was not transported, and the remainder was handled by railroad, waterway, and other modes of transport.

As part of a larger study of construction sand and gravel deposits in the U.S. Exclusive Economic Zone,<sup>9</sup> a U.S. Bureau of Mines study of the Houston construction sand and gravel and crushed stone market concluded that aggregate deposits suitable for near-term commercial use apparently do not exist in the Houston-Galveston offshore region. Large onshore resources and emerging foreign supplies combine to further discourage any possibility of commercial offshore operations. The study was initiated in response to a request from the U.S. Department of the Interior's Minerals Management Service.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 9 presents end-use data for construction sand and gravel production in nine Texas districts depicted in figure 1.

Table 8.—Texas: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand)	28,319	\$107,678	\$3.80
Plaster and gunitite sands	404	2,210	5.47
Concrete products (blocks, bricks, pipe, decorative, etc.)	157	704	4.48
Asphaltic concrete aggregates and other bituminous mixtures	2,108	9,352	4.44
Road base and coverings <sup>1</sup>	3,324	9,272	2.78
Fill	1,700	2,461	1.45
Snow and ice control	W	W	3.64
Railroad ballast	W	W	3.40
Other	1,647	8,801	5.34
Other unspecified <sup>2</sup>	21,904	69,376	3.17
Total <sup>3</sup> or average	59,562	209,855	3.52

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

Table 9.—Texas: Construction sand and gravel sold or used by producers in 1986, by use and district

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup>	1,317	6,977	658	3,204	969	6,278
Asphaltic concrete aggregates and other bituminous mixtures and road base and coverings <sup>2</sup>	510	2,388	W	W	1,132	5,920
Fill	77	242	W	W	--	--
Other unspecified <sup>3</sup>	1,296	4,036	283	965	1,026	2,561
Total <sup>4</sup>	3,199	13,643	940	4,169	3,127	14,758
Use	District 4		District 5		District 6	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup>	1,128	2,739	9,426	38,815	682	3,402
Asphaltic concrete aggregates and other bituminous mixtures and road base and coverings <sup>2</sup>	162	565	689	1,813	W	W
Fill	--	--	304	375	W	W
Other unspecified <sup>3</sup>	750	1,658	8,970	35,383	540	2,077
Total <sup>4</sup>	2,040	4,962	19,388	76,387	1,221	5,479
Use	District 7		District 8		District 9	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup>	2,761	10,058	10,808	34,283	1,132	4,836
Asphaltic concrete aggregates and other bituminous mixtures and road base and coverings <sup>2</sup>	851	1,159	1,115	2,530	871	3,859
Fill	212	442	1,079	1,351	6	6
Other unspecified <sup>3</sup>	6,241	19,811	4,380	11,547	190	575
Total <sup>4</sup>	10,065	31,470	17,383	49,711	2,198	9,276

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

<sup>1</sup>Includes plaster and gunitite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes railroad ballast, snow and ice control, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—United States Borax & Chemical Corp. (a subsidiary of Rio Tinto Zinc Corp. PLC, United Kingdom) bought another Texas silica sand operation, that of Ottawa Silica Co., having acquired Pennsylvania Glass Sand Corp. and its McCulloch County operation in 1985.<sup>10</sup> The Ottawa Silica facility included a sand and kaolin quarry and plant in Limestone County. UNIMIN Corp. operated a third silica sand plant in the State in 1986.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Crushed stone output and value both declined slightly from that of 1985. Some firms made large commitments to upgrading facilities.

On August 5, a milestone 59,390-short-ton bulk shipment of crushed granite aggregates was delivered from Scotland to Houston. The cost advantages of high-volume bulk ocean transportation and low-cost stevedoring allowed the Scottish material to be sold competitively along the gulf coast, according to officials of TXTX Corp. of Houston.<sup>11</sup>

**Sulfur (Frasch).**—Two firms operated Frasch sulfur mines in Texas: Pennzoil Sulphur Co. in Culberson County and Texasgulf Chemicals Co. in Wharton County.

In October 1986, Pennzoil Sulphur was incorporated as a wholly owned subsidiary of Pennzoil Co., previously having been a division of Pennzoil Co. Production from the Culberson County mine was 2,103,223 metric tons, and sales were down about 18% from that of 1985, according to Pennzoil Sulphur's 1986 10K Annual Report to the Securities and Exchange Commission. Average price of sold output was \$136.07 per ton, down \$2.18 from the 1985 price. Proven reserves at the mine at yearend were 35,498,755 tons. During the year, the mine was operated at approximately 83% of design capacity, compared with 101% in 1985. Sulfur sales were primarily to phosphate industry customers for use in the manufacture of phosphate fertilizer materials.

Texasgulf Chemicals, a subsidiary of Elf Aquitaine Inc. of Stamford, CT, produced 359,682 tons of Frasch sulfur at its Newgulf Mine on Boling Dome in Wharton County. Production was down 4% from that of 1985. During its 58 years of operation, the mine's cumulative production has reached 80.9 million tons. In an effort to trim costs, the work force at Newgulf was reduced 26% during the first half of 1986, according to Elf Aquitaine's annual report. The company's Comanche Creek Mine, northeast of Fort Stockton, remained on standby. Texasgulf Chemicals also operated a sulfur shipping terminal at Beaumont, Jefferson County.

Table 10.—Texas: Sulfur produced and shipped from Frasch mines

(Thousand metric tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1982	2,898	2,360	W
1983	1,915	2,468	W
1984	2,257	2,994	W
1985	2,940	2,979	W
1986	2,463	2,506	W

W Withheld to avoid disclosing company proprietary data.

**Talc.**—Output and value of talc increased over that of 1985. Several companies produced gray talc suitable for the ceramics industry, notably from Southern Clay Products Inc.'s Allamore pits, Hudspeth County. The gray color is due to graphite contamination.<sup>12</sup>

**Vermiculite (Exfoliated).**—W. R. Grace & Co. and Vermiculite Products Inc. exfoliated vermiculite from out-of-State sources at plants in Bexar, Dallas, and Harris

Counties. Exfoliated vermiculite output, value, and unit price increased moderately over 1985 figures. Exfoliated vermiculite was used primarily in concrete aggregates but also in fireproofing, insulation, and horticultural agriculture materials.

#### METALS

**Aluminum.**—Primary aluminum production in Texas declined nearly one-fifth in value and output from that of 1985, mirror-

ing the national trend downward. Aluminum Co. of America produced high-purity alumina at its refinery in Point Comfort and sheet ingot at its smelter at Rockdale. Reynolds Metals Co.'s 1.7-million-metric-ton Sherwin alumina plant near Corpus Christi processed bauxite from Australia, Brazil, Guinea, and Jamaica.

Alumax Inc., a subsidiary of AMAX Inc., started production at a new can sheet plant in Texarkana. Substantially all the output was sold to Continental Can Co. Inc. under a long-term contract. The 75,000-short-ton-per-year Texarkana facility included an adjacent recycling operation that converted used beverage cans into rolling ingot, according to the company's 1986 annual report.

**Beryllium.**—Cabot Mining Co., a subsidiary of Cabot Corp. of Waltham, MA, and Cyprus Minerals Co. of Englewood, CO, considered a joint venture to mine beryllium on State-owned land 7 miles northwest of Sierra Blanca, Hudspeth County.

The Sierra Blanca operation may eventually include an open pit mine and a solvent-extraction processing center to convert the bertrandite ore into beryllium oxide. Exploration and a feasibility study were expected to take 18 months to 2 years and cost \$2 million. Initial core drilling at the property indicated that the ore body contains more than 25 million pounds of beryllium oxide at a grade greater than 2%. Brush Wellman Inc.'s beryllium property in Utah was the only other beryllium mine in the United States.

Certain physical properties of beryllium placed it in demand worldwide by electrical, electronics, aerospace, and defense industries.

**Gallium.**—Rhône-Poulenc S.A. planned to construct a gallium refinery at Freeport, Brazoria County. Completion of the plant was scheduled for the latter part of 1988. Reportedly, the plant will have an annual capacity greater than current world demand, which was estimated to be about 45,000 to 50,000 kilograms. Crude gallium feed would be supplied by Rhône-Poulenc's new gallium extraction plant in Australia.

**Iron Ore.**—Iron ore output from Texas properties plunged downward from that of 1985 and 1984. Declines in iron ore production accompanied the closures of steel mills in Texas and left the State with only two of the three producers that were active in 1984. Mathis & Mathis Mining & Exploration Co. operated its iron ore pit and plant in Cass County, and Hudson Bros. Min-

ing Co. Inc., its pit and plant in Cherokee County.

**Iron and Steel.**—To recoup losses from the decline of tubular goods required by the oil industry, some steel producers embarked on a course of diverting production to non-energy products, including bearing-quality precision tubing and environmental control devices. The influx of "unfairly subsidized (or illegal)" imports of finished products allegedly continued at a high level and accounted for one-half the market. It also was alleged that imported pipe and tubing from Africa, Brazil, Canada, Europe, the Far East, Mexico, and South America were being dumped below the foreign producers' cost.

Two steelmakers merged their oilfield supply and service operations, looking for cost-cutting synergies in the resulting new company. The combining of United States Steel Corp.'s (now USX Corp.) Oilwell Div. and Armco Inc.'s National Supply Co. was expected to be completed by yearend 1986. The proposed merger reflected lingering overcapacity nationwide in the oil-pipe production and oil-drilling businesses.

Chaparral Steel Co., Midlothian, was to start rolling larger wide-flange steel beams after June 1986. A 50% interest in Chaparral was purchased by Texas Industries Inc. from Co-Steel International Ltd. of Whitby, Ontario, Canada, in 1985.

Lone Star Steel Co. began on March 17 to temporarily idle about 50% of its facility in Morris County. A blast furnace and two open-hearth furnaces were to be shut down but maintained in condition to restart. The idling caused the release of 2,350 of the firm's 4,000 employees. Lone Star Steel continued to produce steel in electric furnaces and also bought semifinished steel to maintain production at its pipe and tube mills.

Lone Star Technologies Inc., parent of Lone Star Steel Co., known for its oilfield tubing, embarked on a course of diverting production to its nonenergy products, including precision tubing and environmental control devices.<sup>13</sup> Bearing-quality precision tubing is one product the company will use to recoup its lost sales of oil-country tubular goods, which traditionally composed two-thirds of the company's sales and even more of its profits. Prospective customers of the precision tubing were to be automotive, construction equipment, and machine tool manufacturers.

**Tin.**—Associated Metals & Minerals Co., parent of Tex Tin Corp., announced in June

that its smelter at Texas City would begin smelting tin concentrates for Minsur S.A. of Peru. Minsur planned to market the tin in the United States.

- <sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.  
<sup>2</sup>Geologist, Bureau of Economic Geology, The University of Texas at Austin, TX.  
<sup>3</sup>Henry, C. D., and J. G. Price. The Van Horn Mountains Caldera, Trans-Pecos Texas. Univ. TX (Austin), Bur. Econ. Geol. Rep. Invest. 151, 1986, 46 pp.  
 Price, J. G., C. D. Henry, D. F. Parker, and D. S. Barker. Igneous Geology of Trans-Pecos Texas: Field Trip Guide and Research Articles. Univ. TX (Austin), Bur. Econ. Geol. Guideb. 23, 1986, 360 pp.  
 McBride, M. W., and B. Stengl. Computer-Generated List of Nonpetroleum Mineral Producers in Texas. Univ. TX (Austin), Bur. Econ. Geol., 1986, unpaginated.  
<sup>4</sup>Rock Products. Rock Newscope. V. 89, No. 4, Apr. 1986, p. 9.  
 Rich, R. Floating Silos: Wave of Future? Rock Prod.,

v. 89, No. 4, Apr. 1986, pp. 34-37.

- <sup>5</sup>Pit & Quarry. Centex Corp., Lehigh Plan Joint Production, Sales Venture. Apr. 1986, p. 14; Rock Products. Rock Newscope, v. 89, No. 4, Apr. 1986, p. 9; Rock Products. Rock Newscope, No. 9, Aug. 1986, p. 9.  
<sup>6</sup>Rock Products. Rock Newscope. V. 89, No. 12, Dec. 1986, p. 7.  
<sup>7</sup>———. Rock Newscope. V. 89, No. 4, Apr. 1986, p. 9.  
<sup>8</sup>Texas Industrial Expansion. V. 36, No. 5, May 1986.  
<sup>9</sup>U.S. Bureau of Mines. An Economic Reconnaissance of Selected Sand and Gravel Deposits in the U.S. Exclusive Economic Zone. OFR 3-87, 1987, pp. 39-46.  
<sup>10</sup>American Mining Congress Journal. U.S. Borax Acquires Ottawa Silica Co. V. 72, No. 11, June 13, 1986, p. 10.  
<sup>11</sup>Skilling's Mining Review. Foster Yeoman Marks First Shipment of Crushed Granite Aggregate From Its New Glensanda Quarry in Scotland. V. 75, No. 41, Oct. 11, 1986, pp. 6-7.  
<sup>12</sup>Grexa, R. W. North American Talc: Competition in Every Direction. Ind. Miner. (London), No. 237, June 1987, pp. 52-55.  
<sup>13</sup>Texas Industrial Expansion. V. 36, No. 6, June 1986.

Table 11.—Texas: Primary smelters, refineries, and reduction plants

Product, company, plant	Location (county)	Material treated
<b>Aluminum:</b>		
Aluminum Co. of America:		
Point Comfort	Calhoun	Bauxite.
Rockdale (reduction)	Milam	Alumina.
Reynolds Metals Co.:		
Sherwin plant (alumina)	San Patricio	Do.
<b>Antimony:</b>		
ASARCO Incorporated:		
El Paso smelter	El Paso	Ore.
<b>Cadmium:</b>		
ASARCO Incorporated:		
El Paso smelter	do	Do.
<b>Copper:</b>		
ASARCO Incorporated:		
Amarillo refinery <sup>1</sup>	Potter	Blisters and anode.
El Paso smelter	El Paso	Ore and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery <sup>2</sup>	do	Blisters and anode.
<b>Iron:</b>		
Lone Star Steel Co.:		
Daingerfield plant	Morris	Ore and scrap.
<b>Lead:</b>		
ASARCO Incorporated:		
El Paso smelter	El Paso	Ore and concentrates.
<b>Magnesium:</b>		
The Dow Chemical Co.:		
Freeport plant, electrolytic	Brazoria	Seawater.
<b>Tin:</b>		
Tex Tin Corp.:		
Texas City smelter	Galveston	Ore and concentrates.
<b>Zinc:</b>		
ASARCO Incorporated:		
Corpus Christi plant, electrolytic <sup>3</sup>	Nueces	Do.
El Paso fuming plant	El Paso	Dusts and residues.

<sup>1</sup>Asarco's Amarillo refinery also produced gold, nickel sulfate, palladium, platinum, selenium, silver, and tellurium.

<sup>2</sup>Phelps Dodge's El Paso (Nichols) refinery also produced copper sulfate, gold, palladium, platinum, selenium, silver, and tellurium.

<sup>3</sup>Asarco's Corpus Christi refinery also produced cadmium and sulfuric acid.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asphalt (native):</b>			
Azrock Industries Inc -----	84 NE. Loop 410 Suite 480 West San Antonio, TX 78216	Quarry and plant --	Uvalde.
<b>Barite:</b>			
Dresser Industries Inc -----	Box 6504 Houston, TX 77005	Grinding plants ---	Cameron and Galveston.
The Milwhite Co. Inc. <sup>1</sup> -----	Box 15038 Houston, TX 77020	----do -----	Cameron and Harris.
NL Industries Inc -----	Box 1675 Houston, TX 77001	Grinding plant ----	Nueces.
<b>Cement:</b>			
Alamo Cement Co -----	Box 34807 San Antonio, TX 78233	Quarry and plant --	Bexar.
Centex Cement Corp -----	4600 Republic Bank Tower Dallas, TX 75201	Quarries and plant -	Hays and Nueces.
General Portland Inc. <sup>2</sup> -----	Box 324 Dallas, TX 75221	----do -----	Comal, Dallas, Tarrant.
Gifford-Hill & Co. Inc. <sup>3</sup> -----	Box 520 Midlothian, TX 76065	Quarry and plant --	Ellis.
Southwestern Portland Cement Co. <sup>4</sup> -----	Box 1547 Odessa, TX 79760	Quarries and plants -	Ector, El Paso, Potter.
Texas Industries Inc. <sup>5</sup> -----	8100 Carpenter Freeway Dallas, TX 75247	----do -----	Comal and Ellis.
<b>Clays:</b>			
Acme Brick Co., a division of Justin Industries Inc. -----	Box 886 Denton, TX 76202	Pits and plants ----	Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise.
Featherlite Building Products Corp. -----	Box 141 Ranger, TX 76470	Pit and plant -----	Eastland.
Texas Industries Inc -----	Box 4672 Malakoff, TX 77252	Pits and plants ----	Ellis, Fort Bend, Guadalupe, Hen- derson, Van Zandt.
Wolff Inc -----	Box 34870 San Antonio, TX 78265	Pit and plant -----	Guadalupe.
<b>Fluorspar:</b>			
Machaca Resources Inc -----	Box 1396 Alpine, TX 79830	Mine -----	Brewster.
<b>Gypsum:</b>			
Genstar Gypsum Products Co -	Box 720 Sweetwater, TX 79556	Quarry and calcining plant.	Nolan.
Georgia-Pacific Corp -----	900 SW. Fifth Ave. Portland, OR 97204	----do -----	Hardeman.
National Gypsum Co -----	2001 Rexford Rd. Charlotte, NC 28211	Quarries and calcin- ing plants.	Fisher, Kimble, Stonewall.
USG Corp. (parent of United States Gypsum Co.) <sup>6</sup> -----	101 South Wacker Dr. Chicago, IL 60606	Quarry and calcining plant.	Harris and Nolan.
Windsor Gypsum Co -----	McQueeny, TX 78123 ----	Calcining plant ---	Guadalupe.
<b>Iron ore:</b>			
Hudson Bros. Mining Co. Inc --	Box 301 Rusk, TX 75785	Pit and plant -----	Cherokee.
Mathis & Mathis Mining & Exploration Co. -----	1101 Santa Rita Box 2577 Silver City, NM 88062	----do -----	Cass.
<b>Lime:</b>			
Austin White Lime Co -----	Box 9556 Austin, TX 78766	Plant -----	Travis.
Chemical Lime Co -----	Box 473 Republic Bash Bldg. Clifton, TX 76634	----do -----	Boesque.
Holly Sugar Corp -----	Drawer 1778 Hereford, TX 79045	----do -----	Deaf Smith.
Redland Worth Corp -----	17910 Interstate Hwy. 10 West San Antonio, TX 78257	----do -----	Bexar.
Round Rock Lime Co., a sub- sidiary of Dravo Lime Co. -----	Box 38 Blum, TX 76627	----do -----	Hill.
Texas Lime Co., a subsidiary of Rangaire Corp. -----	Box 177 Cleburne, TX 76081	----do -----	Johnson.
<b>Salt:</b>			
Diamond Shamrock Corp -----	717 North Harwood Dallas, TX 75201	----do -----	Chambers.
The Dow Chemical Co. <sup>7</sup> -----	2020 Dow Center Midland, MI 48640	Brine -----	Brazoria.
Morton Thiokol Inc -----	110 North Wacker Dr. Chicago, IL 60606	Underground mine and brine.	Van Zandt.
Texas Brine Corp -----	2000 West Loop South Suite 990 Houston, TX 77027	Brines -----	Harris, Jefferson, Matagorda.

See footnotes at end of table.



Table 12.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Capitol Aggregates Inc. (H. B. Zachry Co.)	Drawer 33240 San Antonio, TX 78233	Stationary plants --	Bexar, Travis, Val Verde.
Centex Materials Inc.-----	Box 2252 Austin, TX 78768	Pits and plants-----	Hays, Somervell, Travis.
El Paso Sand Products Inc.	Box 9008 El Paso, TX 79982	Pit and plant-----	El Paso.
The Fordyce Co.-----	Box 1981 San Antonio, TX 78297	Pits and plants-----	Hidalgo and Victoria.
Ideal Basic Industries Inc., Thorstenberg Materials Co. Inc. Div.	363 North Belt Houston, TX 77054	Pits-----	Colorado and Fayette.
Oglebay Norton Co., Texas Mining Co.	2104 East Randol Mill Rd. Suite 101 Arlington, TX 76011	Pits and plant-----	McCulloch.
Parker Bros. & Co. Inc.---	Box 107 Houston, TX 77001	Stationary plants and dredges.	Colorado, Fayette, Harris, Victoria.
Pioneer Concrete of Texas Inc.	Box 12449 Dallas, TX 75225	Pits and plants-----	Colorado, Dallas, Liberty, Montgomery.
<b>Industrial:</b>			
Pennsylvania Glass Sand Corp.	Box 187 Berkeley Springs, WV 25411	Pits-----	Live Oak and McCulloch.
UNIMIN Corp. <sup>8</sup> -----	50 Locust Ave. New Canaan, CT 06840	Plant-----	Johnson.
U.S. Silica Co. of Texas.---	Box 775128 Sanford Station Los Angeles, CA 90075	Plants-----	Limestone, Live Oak, McCulloch.
<b>Sodium sulfate (natural):</b>			
Ozark-Mahoning Co.-----	1870 South Boulder Tulsa, OK 74119	-----do-----	Gaines and Terry.
<b>Stone:</b>			
Lone Star Industries Inc. <sup>9</sup> ---	Box 86 Houston, TX 77001	-----do-----	Burnet, Nolan, Wise.
Parker Bros. & Co. Inc.-----	Box 107 Houston, TX 77001	Plant-----	Comal.
Texas Crushed Stone Co.-----	Box 1000 Georgetown, TX 78626	Plants-----	Llano and Williamson.
Vulcan Materials Co. <sup>10</sup> -----	Box 7497 Birmingham, AL 35253	-----do-----	Bexar, Grayson, Williamson, Wise.
White's Mines Inc. <sup>11</sup> -----	Box 32688 San Antonio, TX 78216	-----do-----	Brown, Parker, Taylor, Uvalde.
<b>Sulfur:</b>			
<b>Byproduct:</b>			
Amoco Production Co. (Standard Oil Co., Indiana).	Box 591 Tulsa, OK 74102	Secondary recovery --	Andrews, Ector, Galveston, Hockley, Van Zandt, Wood.
Chevron U.S.A. Inc.-----	575 Market St. San Francisco, CA 94105	-----do-----	Crane, El Paso, Hopkins, Jefferson, Karnes.
Exxon Chemical Americas	Box 77253-3272 Houston, TX 77079	-----do-----	Atascosa, Crane, Harris.
Phillips Petroleum Co.---	Bartlesville, OK 74003-----	-----do-----	Andrews, Brazoria, Hopkins, Hutchinson.
Smackover Shell Ltd.-----	Route 2, Box 152 Eustace, TX 75124	-----do-----	Henderson.
Texaco Producing Inc.---	Box 8 Scroggins, TX 75480	-----do-----	Franklin, Freestone, Jefferson.
<b>Frasch:</b>			
Pennzoil Sulphur Co.-----	1906 First City National Bank Houston, TX 77002	Frasch mine-----	Culberson.
Texasgulf Chemicals Co., a subsidiary of Elf Aquitaine Inc.	Glenwood at Glen Eden Box 30321 Raleigh, NC 27622-0321	-----do-----	Wharton.
<b>Talc:</b>			
Clark Minerals Inc.-----	1000 Coolidge St. South Plainfield, NJ 07080	Pits and plant-----	Hudspeth.
Southern Clay Products Inc. <sup>12</sup> ---	Box 44 Gonzales, TX 78629	Pit and plant-----	Do.
Texas Talc Co. (Dal-Tile Corp.)..	Box 17130 Dallas, TX 75217	Pits-----	Do.
Westex Minerals Co. (The Mil- white Co. Inc.).	Box 15038 Houston, TX 77020	Mines and plants --	Culberson and Hudspeth.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Vermiculite (exfoliated):			
W. R. Grace & Co -----	2651 Manila Rd. Dallas, TX 75200	Exfoliating plants --	Bexar and Dallas.
Vermiculite Products Inc -----	Box 7327 Houston, TX 77008	Exfoliating plant --	Harris.

<sup>1</sup>Also clay and shale, Fayette and Walker Counties.

<sup>2</sup>Also clays, Dallas and Guadalupe Counties; sand and gravel, Dallas, Johnson, Tarrant, and Wise Counties; and stone, Comal, Dallas, Tarrant, and Wise Counties.

<sup>3</sup>Also clays, Ellis County; sand and gravel, Brazos, Dallas, Ellis, and McLennan Counties; and crushed stone, Comal, Ellis, Hudspeth, and Wise Counties.

<sup>4</sup>Also clays, Potter County.

<sup>5</sup>Also clays, Ellis, Fort Bend, Guadalupe, Henderson, Navarro, and Van Zandt Counties; sand and gravel, Dallas, Ellis, Parker, Travis, and Wise Counties; and crushed stone, Comal, Ellis, Jack, and Wise Counties.

<sup>6</sup>Also lime, Comal County.

<sup>7</sup>Also magnesium compounds and magnesium chloride for magnesium metal, Brazoria County.

<sup>8</sup>Also industrial sand, Johnson County.

<sup>9</sup>Also cement, Harris and Nolan Counties; and sand and gravel, Colorado, Denton, and Liberty Counties.

<sup>10</sup>Also industrial sand, McCulloch County.

<sup>11</sup>Also native asphalt, Uvalde County.

<sup>12</sup>Also clays, Gonzales County.



# The Mineral Industry of Utah

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

By Lorraine B. Burgin<sup>1</sup>

The value of nonfuel mineral production increased from \$314 million in 1985 to \$374 million in 1986. The total value of industrial mineral output decreased as declines were posted for native asphalt (gilsonite), masonry and portland cement, clays, gypsum, phosphate rock, potassium salts, industrial sand and gravel, and crushed stone. Metal production rose from one-third the total value of nonfuel minerals in 1985 to about

one-half in 1986, with magnesium production reported for the first time (table 1) and a resumption of iron ore and vanadium shipments. However, continued low metal prices and the shutdown of Kennecott's Utah Copper Div. operations from late March 1985 to December 1986 brought a further decline in the quantity and value of copper, gold, molybdenum, and silver output.

Table 1.—Nonfuel mineral production in Utah<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Beryllium concentrates ----- short tons. . .	6,030	\$6	5,738	\$6	6,533	\$7
Cement (portland) - thousand short tons. . .	W	W	W	W	1,014	58,431
Clays ----- do. . . . .	<sup>2</sup> 315	<sup>2</sup> 2,223	332	2,509	305	2,048
Gem stones. . . . .	NA	<sup>e</sup> 80	NA	<sup>e</sup> 80	NA	96
Gold (recoverable content of ores, etc.)						
----- troy ounces. . . . .	W	W	135,489	43,039	W	W
Gypsum ----- thousand short tons. . . . .	277	2,671	413	4,033	470	3,671
Lime ----- do. . . . .	297	16,471	225	11,912	232	13,079
Salt ----- do. . . . .	1,246	28,651	<sup>r</sup> 1,057	<sup>r</sup> 30,013	1,112	31,830
Sand and gravel:						
Construction ----- do. . . . .	15,217	34,507	<sup>e</sup> 14,000	<sup>e</sup> 36,400	16,452	39,763
Industrial ----- do. . . . .	11	W	W	W	6	123
Stone (crushed) ----- do. . . . .	<sup>e</sup> 5,200	<sup>e</sup> 16,400	4,657	14,180	<sup>e</sup> 4,500	<sup>e</sup> 14,100
Vermiculite ----- do. . . . .					W	153
Combined value of asphalt (native), cement (masonry), clays (fuller's earth, 1984), copper, iron ore (usable, 1986), lead (1984), magnesium compounds, magnesium <sup>3</sup> (1986), molybdenum (1984-85), phosphate rock, potassium salts, silver, sodium sulfate (natural), stone (dimension), vanadium (1984, 1986), zinc (1984), and values indicated by symbol W -----	XX	<sup>r</sup> 424,491	XX	<sup>r</sup> 171,792	XX	210,755
Total -----	XX	<sup>r</sup> 525,500	XX	<sup>r</sup> 313,964	XX	374,056

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes certain clays; value included with "Combined value" figure.

<sup>3</sup>Magnesium (refinery production) not reported in 1984 and 1985.

Table 2.—Nonfuel minerals produced in Utah in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Beaver	Stone (crushed).
Box Elder	Stone (crushed), stone (dimension), clays.
Cache	Stone (crushed).
Daggett	Do.
Duchesne	Do.
Garfield	Do.
Grand	Potassium salts, salt.
Iron	Silver.
Juab	Cement, stone (crushed), gypsum, clays.
Kane	Stone (crushed).
Millard	Lime, stone (crushed), beryllium.
Morgan	Cement, stone (crushed).
Salt Lake	Copper, cement, salt, gold, molybdenum, silver, stone (crushed), lime, sand and gravel (industrial).
Sanpete	Gypsum, clays, stone (crushed).
Sevier	Gypsum, salt, clays.
Summit	Clays.
Tooele	Gold, salt, lime, potassium salts, stone (crushed), magnesium compounds, clays.
Uintah	Phosphate rock, stone (crushed), asphalt (native).
Utah	Gold, clays, stone (crushed), silver, copper.
Washington	Stone (crushed).
Weber	Salt, magnesium compounds, sodium sulfate, potassium salts.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Utah business activity

	1984 <sup>a</sup>	1985	1986 <sup>b</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	1,624	1,645	1,665
Total civilian labor force	do.	702	731	755
Unemployment	percent	6.5	5.9	6.0
<b>Employment (nonagricultural):</b>				
Mining total <sup>1</sup>	thousands	12.8	9.7	7.9
Metal mining	do.	4.2	2.1	1.8
Nonmetallic minerals except fuels <sup>2</sup>	do.	.8	.9	.9
Coal mining	do.	2.8	2.9	2.8
Oil and gas extraction <sup>2</sup>	do.	5.0	3.9	2.4
Manufacturing total	do.	94.0	94.0	92.0
Primary metal industries	do.	5.7	4.9	3.5
Stone, clay, and glass products <sup>2</sup>	do.	4.3	4.6	4.4
Chemicals and allied products <sup>2</sup>	do.	2.8	2.8	2.7
Petroleum and coal products <sup>2</sup>	do.	.8	.8	.8
Construction	do.	34.8	35.5	32.5
Transportation and public utilities	do.	36.4	37.0	37.5
Wholesale and retail trade	do.	140.8	147.9	152.6
Finance, insurance, real estate	do.	29.8	31.1	32.9
Services	do.	121.1	131.3	137.6
Government and government enterprises	do.	131.5	137.8	141.3
Total	do.	601.2	624.3	634.3
<b>Personal income:</b>				
Total	millions	\$16,417	\$17,539	\$18,288
Per capita		\$10,110	\$10,661	\$10,981
<b>Hours and earnings:</b>				
Total average weekly hours, production workers		39.9	40.1	39.9
Mining		42.9	42.9	41.3
Total average hourly earnings, production workers		\$8.9	\$9.6	\$10.1
Mining		\$12.3	\$13.3	\$14.2

See footnotes at end of table.

Table 3.—Indicators of Utah business activity—Continued

	1984 <sup>a</sup>	1985	1986 <sup>b</sup>
Earnings by industry: <sup>3</sup>			
Farm income ----- millions .....	\$111	\$96	\$143
Nonfarm ----- do. ....	\$12,670	\$13,504	\$13,966
Mining total ----- do. ....	\$468	\$381	\$329
Metal mining ----- do. ....	\$177	\$92	\$77
Nonmetallic minerals except fuels ----- do. ....	\$23	\$25	\$25
Coal mining ----- do. ....	\$119	\$128	\$130
Oil and gas extraction ----- do. ....	\$149	\$135	\$97
Manufacturing total ----- do. ....	\$2,212	\$2,351	\$2,367
Primary metal industries ----- do. ....	\$220	\$199	\$143
Stone, clay, and glass products ----- do. ....	\$108	\$113	\$114
Chemicals and allied products ----- do. ....	\$80	\$84	\$82
Petroleum and coal products ----- do. ....	\$40	\$42	\$41
Construction ----- do. ....	\$1,071	\$1,100	\$1,041
Transportation and public utilities ----- do. ....	\$1,151	\$1,184	\$1,203
Wholesale and retail trade ----- do. ....	\$2,076	\$2,220	\$2,312
Finance, insurance, real estate ----- do. ....	\$634	\$691	\$771
Services ----- do. ....	\$2,403	\$2,665	\$2,871
Government and government enterprises ----- do. ....	\$2,616	\$2,869	\$3,032
Construction activity:			
Number of private and public residential units authorized <sup>4</sup> -----	19,698	16,525	13,827
Value of nonresidential construction <sup>4</sup> ----- millions .....	\$532.4	\$536.0	\$522.8
Value of State road contract awards <sup>5</sup> ----- do. ....	\$187.2	\$169.1	\$180.0
Shipments of portland and masonry cement to and within the State thousand short tons .....	974	1,061	942
Nonfuel mineral production value:			
Total crude mineral value ----- millions .....	\$525.5	\$314.0	\$374.1
Value per capita ----- do. ....	\$324	\$190	\$225

<sup>a</sup>Preliminary. <sup>b</sup>Revised.<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; totals may not add because of inclusion of data from other sources.<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

Utah's principal mineral commodities, listed in decreasing order of value, included magnesium, portland cement, gold, construction sand and gravel, salt, copper, phosphate rock, crushed stone, and lime. Nationally, in value of production, Utah ranked first in gallium, gilsonite, and beryllium-containing ores; second in potash; third in vanadium and magnesium; and sixth in copper. In the case of gallium, gilsonite, and beryllium ores, Utah was the only producing State; with potash, magnesium, and vanadium, the State was one of three producing States.

**Trends and Developments.**—Although the total value of nonfuel mineral production increased with the first-time posting of magnesium production, Utah's mineral industry was severely affected during the year by the continued shutdown of Kennecott's Utah Copper Div. and other events. Before the Utah Copper Div. was idled, its Bingham Canyon Mine had been the State's principal producer of six important com-

modities, copper, gold, molybdenum, silver, selenium, and sulfuric acid. Although magnesium became the principal metal produced, its output was sharply cut back when a storm on Great Salt Lake destroyed the AMAX Magnesium Corp. solar evaporation ponds. In other reversals, beginning in August, iron and steel production was reduced by the USX Corp. shutdown of USS Inc.'s Geneva Works, idling 1,900 union members through yearend. Despite the resumption of some vanadium production, uranium and its coproduct vanadium remained depressed because of low prices and competition with foreign imports of uranium.

In industrial minerals, a depressed agricultural industry, low prices, and foreign imports of potassium salts contributed to reductions in the output and sales of potassium salts and phosphate rock. The lack of growth in construction affected the production and sales of cement, gypsum, and crushed stone.

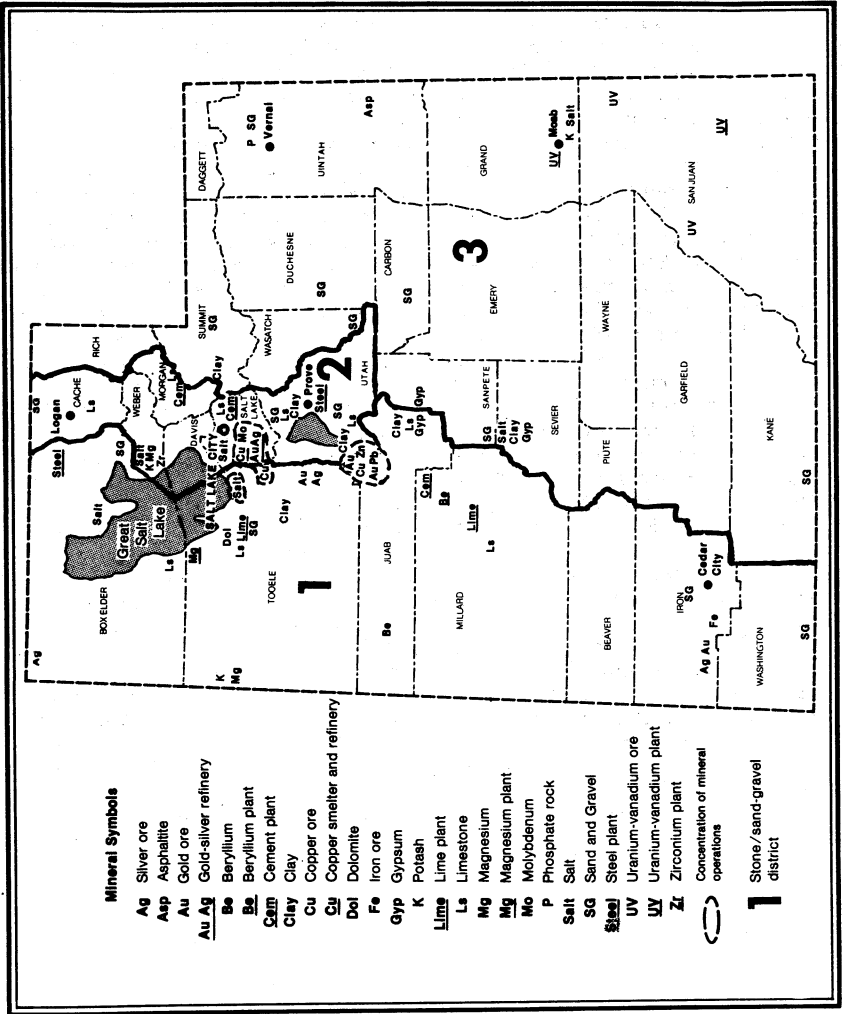


Figure 1.—Principal mineral-producing localities in Utah.

The Utah Bureau of Economic and Business Research reported total permit-authorized residential and nonresidential construction in the State declined 8.5% to \$1.32 billion. Using a different methodology, the F. W. Dodge Div., McGraw-Hill Information Systems Co., found total construction declined 0.9%; residential construction activity increased 4.8%, nonresidential construction increased 12%, and nonbuilding (roads, dams, etc.) construction dropped 34.2%.<sup>2</sup>

Magnesium, potash, and salt industries on the shores of Great Salt Lake were damaged by heavy precipitation and the rising lake, which peaked at 4,211.85 feet above sea level on June 6, surpassing the historic high set in 1873. Although evaporation during the summer and fall months lowered the lake level, a higher than average seasonal climb continued through yearend. In May, seeking a partial solution to the rising lake, the legislature authorized a \$70 million program to pump excess lake waters to the west desert. Construction began on dikes, canals, and a new 2-1/2-foot-deep lake covering a 500-square-mile area. Great Salt Lake was expected to be lowered 16 inches the first year and 8 inches each year thereafter. Saturated brines would be recirculated back to Great Salt Lake for use by various industries.

**Exploration Activities.**—Exploration near Eureka resumed with Sunshine Mining Co. beginning an underground drilling program at the Burgin Mine, East Tintic mining district, Utah County. Commercial-grade mineralization was encountered in all drill holes; the most significant assayed an average of 63 troy ounces of silver, 640 pounds of lead, and 94 pounds of zinc per short ton. In December, Western Mining Corp. Holdings Ltd. of Australia leased the Chief Consolidated Mining Co. property, an old major silver-lead-zinc producer in the Main Tintic district, Juab County, formerly leased to ASARCO Incorporated. Surface drilling was expected to begin in mid-1987.<sup>3</sup>

The Utah Geological and Mineral Survey published a study on minerals exploration and mineral resource appraisal in the Antelope Range mining district, Iron County, 20 miles west of Cedar City.<sup>4</sup>

**Legislation and Government Programs.**—The 1986 General Session of the 46th legislature passed and the Governor signed eight bills related to mining. Senate bill 72 provided for the assessment of metaliferous mines at 100% of their reasonable, fair cash value, and a primary use test for determining whether certain property pertained to mines for taxation purposes. House bill 71 clarified mining and mineral industry definitions (for example, a small mining operation meant an operation disturbing less than 5 onsite acres); required the Board of Oil, Gas, and Mining to promulgate rules concerning surety for mining operations; clarified the procedure for refusing, withholding, or withdrawing a notice of intention for exploration, mining, and reclamation; and made other technical corrections. Under House bill 157, corporate takeovers would be regulated and require disclosures. House bills 207 and 208 related to hazardous waste problems, and Senate bills 67, 134, and 135 to nuclear and radioactive materials. House Concurrent Resolution 4 requested the U.S. Congress, the President, and the U.S. Department of Energy to take actions to reestablish the viability of the Nation's uranium industry. In a special session, the legislature reconvened and passed House bill 6, which appropriated \$30 million from the State's Water Resource Conservation and Development Fund and authorized issuance of \$41.7 million of General Obligation bonds for financing the west desert pumping project.

U.S. Bureau of Mines Salt Lake City Research Center activities, through direct appropriation and cooperative research programs with industry, in fiscal year 1986, included further studies on the beneficiation of oxide ores using column flotation and the external bubble generation system designed by the Bureau. Other research important in Utah and other copper-producing States was the development of a continuous ion exchange process to recover cobalt from spent copper leach solutions. At two major U.S. leaching operations, the potential existed for the annual recovery of 1,500,000 pounds of cobalt, plus copper and nickel as byproducts.<sup>5</sup>



## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Asphalt (Native) and Other Bitumens.**—American Gilsonite Co., a division of Chevron Resources Co., a subsidiary of Chevron Corp., and Ziegler Chemical and Mineral Corp. produced gilsonite, a solidified hydrocarbon found only in Colorado and Utah. Hydrocarbon Mining Co., a subsidiary of Oberon Oil Inc., closed its operation. Mined from veins near Bonanza, Uintah County, gilsonite production declined about 15% because of the drastic cutback in oil well drilling; however, its value remained relatively stable, though weakened. The product was also marketed for automobile body sealer and radiator paint, cement for sand molds in foundries, and other uses.

**Cement.**—Finished portland cement production declined and sales dropped substantially in quantity and in value as residential and public works construction decreased. The average price per short ton of finished portland cement was \$57.62 in 1986. Masonry cement output and sales declined substantially, with Ideal Basic Industries Inc. the only producer.

The three companies manufacturing and shipping portland cement were the Southwestern Portland Cement Co. dry-process plant at Leamington, Millard County; the Ideal Basic Industries wet-process plant at Devils Slide, Morgan County; and the Lone Star Industries Inc. wet-process plant at Salt Lake City. Ideal Basic Industries experienced financial difficulties and, in a debt restructuring plan completed December 24, 1986, Holdernam Inc., a wholly owned subsidiary of "Holderbank" Financiere Glaris Ltd., a Swiss corporation, became the 68.2% owner of the company. Holderbank is one of the largest cement companies in the world.

**Clays.**—Total clay and shale output, including bentonite and common clay, declined in quantity and value; the average unit value fell from \$7.55 in 1985 to \$6.72. Swelling bentonite production dropped 45% in quantity and 29% in value. No fire clay was mined in 1986.

Producers of common clay included Interpace Corp., Interstate Brick Co., Redmond Clay and Salt Co., Southwestern Portland Cement, and Utelite Corp.

The common clays were used mainly for manufacturing face brick and lightweight aggregate, followed by portland cement, waterproof sealant, and animal feed. The

lightweight aggregate was used largely in structural concrete and concrete block. Swelling bentonite was used for animal feed and drilling mud.

**Gem Stones.**—Gem stones production increased in value in 1986. A rare mineral, durangite,  $\text{NaAl}(\text{AsO}_4)\text{F}$ , was found in a localized zone of complex mineralogy in the Thomas Range.<sup>6</sup>

**Graphite (Synthetic).**—Hercules Inc., Aerospace Div., produced synthetic graphite high-modulus fibers at its Bacchus Works near Salt Lake City. The fibers were manufactured for aerospace equipment, leg braces, tennis rackets, and other uses where weight was an important factor. The 2,000-pound Voyager plane that circled the globe without refueling in 1986 was 90% composed of graphite material manufactured at the Utah Hercules plant.

**Gypsum.**—Georgia-Pacific Corp. and United States Gypsum Co., a subsidiary of USG Corp., continued as the principal producers of crude and calcined gypsum. Gypsum was open pit mined northeast of the companies' crushing and calcining facilities for the manufacture of wallboard at Sigurd, Sevier County. At the mouth of Salt Creek Canyon, east of Nephi, Juab County, Thomas Peck & Sons Inc. mined gypsum for use in the manufacture of cement in Juab and Salt Lake Counties.

Crude gypsum production increased in quantity, but its value declined; output of calcined gypsum increased 14%, and its value dropped 12%, reflecting increased competition in the marketplace.

**Lime.**—Quicklime and hydrated lime output gained in quantity and value, although Kennecott produced no lime in 1986 and the USS Geneva Works were closed nearly a half year. Lime producers included Chemstar Inc., formerly Genstar Corp. of Toronto, Canada, at Grantsville, Tooele County; Continental Lime Inc., a subsidiary of Steel Bros. Canada Ltd., about 35 miles south of Delta, Millard County; and Utah Marblehead Lime Co., a subsidiary of General Dynamics Corp., 35 miles northwest of Grantsville, Tooele County. Chemstar was the sole producer of hydrated lime. Utah Marblehead and Chemstar produced a dead-burned dolomite for use in the steel industry.

**Magnesium Compounds.**—Production of magnesium chloride brines about doubled and its value rose substantially as Kaiser

Aluminum & Chemical shipped additional brines to the AMAX Magnesium facility at Rowley after AMAX Magnesium's solar ponds on Great Salt Lake were destroyed by a June 1986 storm. Situated on the Bonneville Salt Flats, near Wendover, Tooele County, Kaiser Aluminum & Chemical became the principal producer of magnesium compounds in the State, recovering the compounds and other products from subsurface brines. Great Salt Lake Minerals & Chemicals Corp. produced magnesium chloride and other products from the brines of Great Salt Lake west of Ogden at Little Mountain, Weber County. However, that output was sold for use primarily as a dust suppressant for roads and industrial areas and for use in the sugar beet processing industry.

**Perlite (Expanded).**—Perlite continued to be shipped in from out of State for expansion at the Pax Co. plant in Salt Lake County. Production of the treated product at the Sigurd Georgia-Pacific plant ceased. Although the State output declined, its value increased dramatically.

**Phosphate Rock.**—Marketable phosphate rock production increased about 7% in quantity as Chevron Resources expanded its Vernal operations; however, the value of that output declined more than 16% when the market for fertilizer fell. Further reflecting the depressed agriculture industry, the combined output for Idaho, Montana, and Utah, which represented 8% of the Nation's production, declined 26% in quantity and 41% in value.

The only producer in the State, Chevron Resources, mined and processed phosphate rock from the Upper Permian Age Park City Formation, 12 miles north of Vernal. Chevron Resources' \$25 million phosphate fertilizer complex constructed in Utah and Wyoming was completed and dedicated on September 8 and 9. The project included a \$70 million modernization and expansion of the mine and beneficiation plant at Vernal, and the 94-mile, 10-inch pipeline to slurry phosphate rock concentrate to the new ammonium phosphate fertilizer plant at Rock Springs, WY. The Vernal operation production capacity was expected to be raised from about 800,000 short tons to 1.3 million tons per year. By September, about 156 workers were employed at the Vernal facilities. After Kennecott shut down the Garfield smelter, which supplied the sulfur for the conversion of phosphate concentrates to ammonium phosphate and superphosphoric acid, Chevron Resources' Garfield plant was

closed and sulfur was obtained from the company's Carter Creek, WY, natural gas stripping plant.

**Potash.**—Nationally, Utah ranked third in potash sales, behind New Mexico and California. Because of the continued slack demand for fertilizers and competition with foreign imports, production declined about 27%. Sales dipped 1%, and low prices for potassium muriate salts dropped the value of those sales more than 19%.

Texasgulf Chemicals Co. of Texasgulf Inc. and Kaiser Chemicals of Kaiser Aluminum & Chemical, recovered potassium salts. Texasgulf Chemicals was a subsidiary of Elf Aquitaine Inc., a Delaware corporation, in turn owned by Société Nationale Elf Aquitaine, of Paris, a large multinational oil, gas, chemical, and pharmaceutical company. According to the Elf Aquitaine 1986 annual report, potash production declined 34% to 107,000 short tons in 1986 and sales were 89,000 tons, down 16% from those of 1985 because of a depressed demand for fertilizers. At its Cane Creek operation near Moab, Grand County, Texasgulf Chemicals solution-mined potassium salts from a depth of over 2,700 feet. Brines were deposited on solar evaporation ponds, from which the salts were harvested and then processed by flotation for the recovery of potash (sylvite) and a byproduct salt (halite).

The Kaiser Chemicals solar evaporation operation near Wendover collected subsurface brines in ditches on the Bonneville Salt Flats of the Great Salt Lake Desert. The brines were concentrated in evaporation ponds, and the potassium salts were harvested and processed through a flotation concentrator to separate the sodium chloride (halite) and potassium chloride (sylvite).

Great Salt Lake Minerals, principal producer of domestic sulfate of potash (also called potassium sulfate), ceased production of the potassium salts after the company's solar evaporation ponds were flooded on May 5, 1984. Repairs on the system were expected to require another several years before the product could again be harvested.

Climax Chemical Co. produced potassium sulfate, sodium sulfate, and byproduct hydrochloric acid from potassium chloride.

**Salt.**—Solar salt was produced in Grand County by Texasgulf Chemicals; in Salt Lake County by Morton Salt Co., a division of Morton-Thiokol Inc.; in Tooele County by American Salt Co., a subsidiary of General Host Corp., and by Sol-Aire Salt & Chemical

Co.; and in Weber County by Great Salt Lake Minerals. Moab Brine Co., a subsidiary of La Sal Oil Co., recovered salt from brine in Grand County, and Redmond Clay and Salt mined rock salt at its American Orsa open pit at Redmond.

Salt production declined about 11% and sales fell 5%; however, its value increased 6%. Flooding on the southern shores of the lake continued to affect industries in that area. In its 1986 annual report, General Host showed its subsidiary, American Salt, with an operating profit; however, production was down 15% from that of 1985, owing in part to the partial flooding of its facilities on Great Salt Lake. In 1985, the then Lakepoint Salt Co., a subsidiary of Domtar Industries Inc., lost its solar ponds because of heavy precipitation and the rising level of Great Salt Lake. Lakepoint Salt was purchased by AMAX Inc., renamed Sol-Aire Salt & Chemical Co., and assigned to market salt precipitate recovered as a byproduct at the AMAX Magnesium Div. magnesium operation. However, at yearend 1986, AMAX Magnesium reached an agreement in principle to sell Sol-Aire to Diamond Crystal Salt Co., St. Clair, MI, for \$800,000 and future royalties based on salt shipments. According to the Gulf Resources & Chemicals Corp. 1986 annual report, Great Salt Lake Minerals increased its processed salt production from 260,000 short tons in

1985 to 293,800 tons in 1986; however, its wet common salt produced for sale declined from 244,000 tons in 1985 to 238,500 tons in 1986.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Construction sand and gravel production in Utah increased in quantity and value. In 1986, 77 producers produced construction sand and gravel in 24 counties. The major producing counties were Salt Lake, with more than 38% of the State's total; Davis, with about 11%; and Juab, with about 9%. Listed in descending order of output, the following leading producers shipped more than 57% of the State's total sand and gravel: Monroc Inc., LeGrand Johnson Construction Inc., Savage Rock Products, Jack B. Parson Co. Inc., Gibbons & Reed Co., Pioneer Sand & Gravel Co., Harper Excavating Inc., Geneva Rock Products Inc., Sanpete County Highway Department, and Kiewit Western Co. The major producers were primarily in the northern part of the State, with access to markets near the Salt Lake City population center.

Table 4.—Utah: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	1,314	\$6,039	\$4.60
Plaster and gunitite sands -----	38	190	5.00
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	W	W	4.00
Asphaltic concrete aggregates and other bituminous mixtures -----	1,490	4,135	2.78
Road base and coverings -----	4,413	9,554	2.16
Fill -----	1,227	1,889	1.54
Snow and ice control -----	27	33	1.22
Other -----	120	443	3.69
Other unspecified <sup>1</sup> -----	7,823	17,480	2.23
Total or average -----	16,452	39,763	2.42

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Table 5.—Utah: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates <sup>1</sup> -----	592	1,546	294	1,289	466	3,394
Asphaltic concrete aggregates and other bituminous mixtures-----	500	1,144	684	1,715	305	1,275
Road base and coverings-----	579	1,106	2,658	4,862	1,176	3,587
Fill-----	82	168	1,141	1,715	4	7
Other <sup>2</sup> -----	43	81	80	316	25	79
Other unspecified <sup>3</sup> -----	1,635	3,805	5,205	11,981	983	1,695
<b>Total</b> <sup>4</sup> -----	<b>3,431</b>	<b>7,848</b>	<b>10,062</b>	<b>21,878</b>	<b>2,959</b>	<b>10,036</b>

<sup>1</sup>Includes concrete sand and plaster and gunite sands.<sup>2</sup>Includes concrete products (blocks, bricks, pipe, decorative, etc.) and snow and ice control.<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Salt Lake Valley Sand & Gravel Co.'s shipments of industrial sand and gravel from its Nash pit, Salt Lake County, declined in quantity and value.

**Sodium Sulfate.**—In 1986, sodium sulfate production increased in quantity and value. Great Salt Lake Minerals resumed production for the first year after the May 5, 1984, dike breach interrupted its 1985 harvest. However, the output was reestablished at a lower rate than in previous years.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—The quantity and value of crushed stone production was estimated to have decreased in 1986 with the decline in construction and mining.

Rockfill obtained from limestone quarries at Lakeside and Hogup Ridge was used by the Southern Pacific Transportation Co. to repair 29 miles of storm-damaged track and causeway across the north arm and adjacent shore of Great Salt Lake. The company was scheduled to build 4 feet of freeboard above the lake by February 1987 when the State's pumping project on Great Salt Lake was to begin lowering the lake to a more normal level.

For the fourth time since 1983, the Union Pacific Railroad on the southern shore of the lake raised its track bed. In 1986, approximately 11 miles of track bed was raised about 2-1/2 feet, at a cost of \$5 million.

**Sulfur (Recovered).**—Chevron Oil Co. recovered sulfur from its petroleum refinery in Salt Lake County. Production doubled, and the quantity and value of sales increased about 29%.

**Vermiculite (Exfoliated).**—Intermountain Products Inc. produced exfoliated vermiculite at its plant in Salt Lake City; the vermiculite was shipped in from out of State. The product was marketed for insulation, fireproofing, soil conditioning, concrete and plaster aggregates, and soil mixes.

## METALS

**Beryllium.**—Beryllium ore production increased in quantity and value in 1986 with Brush Wellman Inc. continuing as the principal domestic producer of beryllium. The surface-mined bertrandite ores were trucked from the Topaz-Spor Mountain area, Juab County, to the processing plant north of Delta, Millard County, where a hydrometallurgical process was used to extract beryllium hydroxide from the ores. Imported beryl ores were also treated at the plant. The product of the plant was shipped to Elmore, OH, to be converted to metallic beryllium, beryllium alloys, and beryllia ceramic. According to the Brush Wellman 1986 annual report, bertrandite ore processed in 1986 increased from 95,000 to 110,000 short tons, and additional drilling raised estimated ore reserves from 5.7 million to 6 million tons.

Emery Energy Inc., formerly Moody Beryllium Co., held more than 7,000 acres of claims adjacent to the Brush Wellman properties in the Topaz Mountain area, Juab County. At midyear, the company announced a joint venture with Cominco American Incorporated (51%) to mine and mill the bertrandite ores. A feasibility study indicated a mine-mill complex could produce 6.2 million pounds of beryllium oxide over 13 years at a cost of \$14 million.<sup>7</sup> Estimated ore reserves were reported to be 500,000 short tons of 0.64% beryllium oxide.<sup>8</sup> In December, the company name was

officially changed to Beryllium International Corp.

**Copper.**—The shutdown of Kennecott's Utah Copper Div. concentrator operations from March 1985 to December 1986 dropped copper production in the State about 46% in quantity and value compared with that of 1985, and over 87% below 1984 levels, the last year of full operation. Kennecott was the State's only copper producer in 1986, primarily from its leach operations in Bingham Canyon. As part of a labor contract settlement in July 1986, Kennecott agreed to resume copper production and to proceed with the company's \$400 million modernization plan; approximately 700 workers were recalled in September. Open pit mining operations began with stripping overburden and stockpiling ore until the Magna concentrator could be restarted in December. By January 1, approximately 1,330 workers had been brought back to work. Rehabilitation of the smelter and refinery was expected to be complete by mid-1987.

The July labor negotiations resulted in a 4-year contract that reduced the \$13.77 average hourly wage about 24%, or \$3.32 per hour, and eliminated the cost-of-living allowance. Benefits were made comparable to those of competitors and resulted in total

labor cost reductions of 30%.

In late 1985, Kennecott's parent company, The Standard Oil Co. of Cleveland, OH (55% owned by British Petroleum Co. Ltd., London), approved a plan to proceed with the \$400 million modernization of its Utah Copper Div. operation. The project included construction of in-pit ore crushing facilities, an ore-conveying system, a new grinding plant and flotation concentrator at Copper-ton, and pipelines to slurry the concentrates to the smelter at Garfield and the tailings to ponds at Magna. Water would be recycled back to Copper-ton. With the completion of the modernization, scheduled for late 1988, the Utah Copper Div. was expected to produce 77,000 short tons of ore per day and 185,000 tons of refined copper annually, plus byproduct gold, molybdenum, selenium, silver, and sulfuric acid. The operation would employ about 2,000 hourly and salaried workers, compared with 7,400 in 1981.

In October, the State filed a claim against Kennecott, alleging natural resource damages associated with the ground water at the mouth of Bingham Canyon, 25 miles southwest of Salt Lake City. However, a stay was granted until a 5-year study under way by Kennecott and government agencies would be completed in 1988.

**Table 6.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county**

County	Mines producing <sup>1</sup>		Material sold or treated <sup>2</sup> (metric tons)	Gold		Silver		
	Lode	Placer		Troy ounces	Value	Troy ounces	Value	
1984, total	6	--	W	W	W	W	W	W
1985, total	4	--	W	135,489	\$43,039,301	W	W	W
<b>1986:</b>								
Iron	1	--	277,342	800	294,592	2,290,000	\$12,526,300	W
Salt Lake	1	1	W	W	W	W	W	W
Tooele	1	--	1,878,567	111,007	40,877,217	23,361	127,785	W
Total	3	1	W	W	W	W	W	W
	Copper		Lead		Zinc		Total value	
	Metric tons	Value	Metric tons	Value	Metric tons	Value		
1984, total	W	W	W	W	W	W	W	W
1985, total	W	W	--	--	--	--	--	W
<b>1986:</b>								
Iron	--	--	--	--	--	--	\$12,820,892	W
Salt Lake	W	W	--	--	--	--	--	W
Tooele	--	--	--	--	--	--	41,005,002	W
Total	W	W	--	--	--	--	--	W

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Operations at which metals were recovered only from tailings or precipitates are not counted as producing mines.

<sup>2</sup>Does not include gravel washed.

**Table 7.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by class of ore or other source material**

Source	Number of mines <sup>1</sup>	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold <sup>2</sup> -----	1	1,878,587	111,007	23,361	--	--	--
Silver <sup>2</sup> -----	1	277,342	800	2,290,000	--	--	--
Total -----	2	2,155,909	111,807	2,313,361	--	--	--
Copper-----	1	W	W	W	W	--	--
Other lode material: Copper precipitates-----	1	W	--	--	W	--	--
Total lode -----	3	W	W	W	W	--	--
Placer-----	1	--	W	--	--	--	--
Grand total -----	4	W	W	W	W	--	--

W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Detail will not add to totals shown because some mines produce more than 1 class of material.<sup>2</sup>Includes material that was leached.**Table 8.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1986, by type of material processed and method of recovery**

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation-----	111,807	2,313,361	--	--	--
Smelting of concentrates-----	W	W	W	--	--
Direct smelting of precipitates-----	--	--	W	--	--
Total lode material -----	W	W	W	--	--
Placer-----	W	--	--	--	--
Grand total -----	W	W	W	--	--

W Withheld to avoid disclosing company proprietary data.

In an environmental enforcement action, the Utah Air Conservation Committee ordered the company to prepare plans for controlling dust from its massive tailings ponds near Magna, 16 miles north of the mine. When the Utah Copper Div. operation shut down, the deactivated ponds dried out, and citizens in the area complained about blowing dust. The three-part plan would outline procedures to suppress dust before the ponds were reactivated in January 1987, during any temporary shutdown, and after permanent closure of the operation.

In other reclamation work, The Anaconda Minerals Co., a division of Atlantic Richfield Co., began a \$5 million project to cover and revegetate the tailings pond on its permanently closed Carr Fork property, Tooele County.

**Gallium and Germanium.**—St. George Mining Corp., a subsidiary of Musto Explorations Ltd., Vancouver, Canada, became the world's first primary producer of gallium and germanium dioxide in 1986. The

first shipment of gallium from the Apex Project was made on April 14, and of germanium oxide during the week of August 11. Musto reported the plant processed 10,270 dry short tons for the production of 750 kilograms of gallium and 2,555 kilograms of germanium during the year.<sup>6</sup> Situated near Shivwits, west of St. George, the plant was about 10 miles northeast of its raw material source, the old Apex Mine. An intermittent producer of copper, lead, and silver from 1883 to 1952, and gallium and germanium in 1986, the mine lies in the Tutsagubet mining district in the southern end of the Beaver Dam Mountains, Washington County. Recent investigations indicated the ores may have been deposited in a solution-collapse breccia pipe instead of a fault breccia as previously postulated. Further exploration for mineralized breccia pipes, similar to the Apex ore body, was planned for 1987. The company estimated proven ore reserves in 1986 to be 180,000 tons containing 0.042% gallium and 0.115%

germanium. Approximately 60 workers were employed at the operation.

**Gold.**—The Mercur Mine of Barrick Mercur Gold Mines Inc., a subsidiary of American Barrick Resources Corp., Toronto, Canada, principal producer of gold in the State, ranked 11th in the Nation's gold output. Byproduct gold was also recovered at Hecla Mining Co.'s Escalante silver mine and the Kennecott Bingham Canyon Mine. The shutdown at Bingham Canyon brought a more than 15% decline in Utah's gold production; however, because the average price of gold rose from \$317.66 per troy ounce in 1985 to \$368.24 in 1986, the value of that output fell only 2%.

American Barrick Resources reported the Mercur Mine produced a record high 105,327 ounces of gold from its mill and 5,680 ounces from its dump leach facilities. The nearly 24% increase was attributed to operational improvements costing \$7 million that included constructing two dump leach pads, installing two additional carbon-in-leach tanks in the mill, and extending the tailings impoundment area.<sup>10</sup>

**Iron Ore and Steel.**—USS shipped iron ore mined and processed at the Comstock Mine, Iron Springs district, Iron County, and a small amount of lean ore remaining from previous operators.<sup>11</sup>

A 43% decrease in pig iron production was attributed, in part, to the 5-month shutdown of the USS Geneva Works at Orem, Utah County. The work stoppage that began on August 1, when USX, parent company of USS, and representatives of the United Steelworkers of America failed to reach a labor contract agreement, continued through yearend. Among the changes sought by the company were paycuts of about \$3.25 per hour and changes in seniority rules and job classifications. In the past 5 years, employment at the Geneva Works dropped from about 5,000 workers to less than 2,500.

The USS and Pohang Iron and Steel Co. Ltd. (POSCO), Republic of Korea, joint venture, became effective on April 1, 1986, called USS-POSCO Industries. The company was established to own, operate, and modernize the USS steel operation in Pittsburg, CA. As it had for many years, the Geneva Works was expected to supply the California plant with about 70% of its hot-rolled steel until October 1989. After that date, Federal import restrictions are scheduled to expire and, according to the agreement, USS-POSCO will become the Pittsburg plant's primary source for semifinished coil.

Concern mounted that the Geneva steel plant, the last of the integrated basic steel plants in the Western United States, would not reopen. Industry analysts pointed out threats to the plant's future, including the loss of its principal California market, a need for completely modernizing the Geneva facilities, the sell-off or closing of several raw material sources and steel service centers, and the 700- to 900-mile distance to west coast markets. In addition, environmental problems had to be addressed. For example, on February 3, 1986, the U.S. Environmental Protection Agency filed suit in the U.S. District Court against USX, alleging that Geneva discharged pollutants in Utah Lake in 1985. The agency sought \$3.5 million for the violation.

In February, a 20-member Geneva Advisory Board was created to raise funds for a feasibility study to determine if the Utah plant could remain competitive after 1989. The board, which included union representatives, managers, State and local government officials, and business leaders, would direct the investigation of cost, price, and market data and, if the plant were permanently closed, try to determine the direction of the community's economy. By yearend, \$100,000 had been raised for the study from the union, Utah County, and USX; the Federal Economic Development Agency had given preliminary approval of \$200,000 toward the study.

Nucor Steel Div. of Nucor Corp. operated a 400,000-short-ton-per-year steel minimill at Plymouth, Box Elder County. At the plant, an electric arc furnace melted scrap steel for pouring into a continuous-casting billet system. Products included angles, reinforcing bars, channels, flats, and coiled rounds. In March, a \$30 million plant expansion was announced for manufacturing merchant bars and shapes in smaller sizes. At Brigham City, Nucor Steel's Vulcraft Div. produced joists and joist girders; its Cold Finish Div., cold-finished steel products; and its Grinding Balls Div., grinding balls for the mining industry. About 300 workers were employed at the Nucor Steel Plymouth operation, where production personnel were nonunion and worked under a group incentive plan that provided additional compensation each week for increased performance.

**Magnesium.**—Magnesium production declined in quantity and value at the AMAX Magnesium plant at Rowley, Tooele County. According to the AMAX Inc. 1985 and 1986 10K Annual Reports to the Securities and

Exchange Commission, the company's 1986 magnesium production declined to 27,800 short tons, compared with 31,500 tons in 1985. AMAX Magnesium recovered magnesium from Great Salt Lake brines that were concentrated in solar evaporation ponds, processed into magnesium chloride, and electrolytically separated into magnesium metal; chlorine and sodium chloride were produced as byproducts. On June 7, a severe storm caused Great Salt Lake to breach the 13-mile main protective dike surrounding the company's solar evaporation pond system. Brine waters were diluted and rendered unusable. For the remainder of the year, the plant operated on stockpiled material and brines purchased from the Kaiser Aluminum & Chemical Corp. potash plant at Wendover. AMAX Magnesium elected not to repair the dike and flooded pond system and, at yearend, was considering various options for the future, including constructing a new \$20 million solar evaporation pond system at Knolls, adjacent to areas being flooded as part of the State's west desert pumping project.

**Molybdenum.**—Shutdown of Kennecott's Utah Copper Div.'s Bingham Canyon Mine, the only molybdenum producer in the State, continued to reduce drastically the production and shipments of molybdenum concentrate. A small quantity of molybdenum concentrate was produced; however, no shipments were reported in 1986. Another factor in the lack of shipments was the dealer price for molybdenic oxide, which fell from an average \$3.33 per pound in 1985 to \$2.92 in 1986.

**Silver.**—Silver production fell 12% in quantity and about 22% in value as the average price of the metal declined from \$6.14 per troy ounce to \$5.47. The Escalante Mine of Hecla, the primary producer of silver in Utah, was ranked fourth in the Nation. According to the Hecla 1986 annual report, 2,274,924 ounces of silver was recovered, compared with 2,438,978 ounces in 1985. To reduce costs, workers' hourly wages were reduced 10% and a temporary rate reduction was negotiated with the Dixie Escalante Rural Electric Association. About 120 workers were employed at the operation.

Situated 42 miles west of Cedar City, Iron County, the deposit, containing silver mineralization and minor amounts of lead and zinc, was in an epithermal quartz-calcite vein extending 5,000 feet along the strike, more than 800 feet deep, and averaging 18 feet wide. The company estimated proven

and probable ore reserves to be 917,700 short tons with an average grade of 9.4 ounces of silver per ton.

Producers of byproduct silver included Kennecott's Bingham Canyon Mine and Barrick Mercur's Mercur Mine.

**Vanadium-Uranium.**—Of the three States, Idaho, Colorado, and Utah, that recovered vanadium in 1986, Utah ranked third. At the White Mesa mill, 6 miles south of Blanding, a joint venture of Umetco Minerals Corp. (70%) and Energy Fuels Nuclear Inc. (30%) processed ores primarily for Energy Fuels' Arizona uranium operations; however, a small amount of byproduct vanadium was recovered from uraniumiferous sandstone ores shipped to Blanding by independent operators on the Colorado Plateau. The White Mesa mill had the capacity to produce 600,000 pounds of yellowcake per year. Approximately 115 workers were employed in 1986.

Although Atlas Corp.'s uranium-vanadium mines near Moab remained on standby, the company reported selling 455,000 pounds of  $U_3O_8$  out of inventory during its fiscal year 1986; its vanadium inventory was sold out in 1985. Should market conditions and the price of  $U_3O_8$  allow, company operations could be reactivated within 8 weeks and development of the Farley uranium and vanadium deposit, near Ticaboo, Garfield County, could proceed.

Rio Algom Mining Corp. processed uranium ores, but although vanadium was present in the ores, no vanadium was recovered.

Uranium and, consequently, vanadium output continued severely depressed because of low prices for  $U_3O_8$  and competition with increased imports of natural and enriched uranium. Nuexco's Exchange Value prices for  $U_3O_8$  in concentrates hovered in the \$16.75 to \$17.25 per pound range throughout the year. As it had since 1981, the Metals Week price for domestic 98% fused  $V_2O_5$  (metallurgical grade) remained at \$3.65 per pound of  $V_2O_5$ . Uranium producers continued to protest uranium imports and held that, according to the Atomic Energy Act of 1963, Section 161 (v), the U.S. Department of Energy must restrict enrichment of foreign-source uranium in order to fulfill its legal responsibility to maintain a viable domestic uranium industry. At yearend, the industry was awaiting a 10th Circuit Court of Appeals decision on the issue.<sup>12</sup>

Through the year, Argee Corp., Denver, CO, removed radioactive tailings from the dismantled Vitro Chemical Co. uranium-



vanadium plantsite in metropolitan Salt Lake City. After the material had been transported by rail to a remote area in western Tooele County at a cost of about \$46 million, an additional \$4 million was required to compensate for moving the wetter-than-expected material.

**Zirconium.**—At its plant south of Ogden, Weber County, Western Zirconium Inc. continued to produce primary zirconium sponge and coproduct hafnium sponge from zirconium concentrates imported from Australia. The zirconium sponge was converted to ingot.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Denver, CO.

<sup>2</sup>Bureau of Economic and Business Research. Utah Construction Report. V. 29, No. 4, 1986, 20 pp.

<sup>3</sup>Chief Consolidated Mining Co. 1986 Annual Report. P. 1.

<sup>4</sup>Shubat, M. The Antelope Range Mining District Study. Utah Geol. and Miner. Surv., Surv. Notes, v. 20, No. 3, Fall 1986, pp. 3-6.

<sup>5</sup>Bureau of Mines Staff. Bureau of Mines Research, 1986; A Summary of Significant Results in Mineral Technology and Economics. 131 pp.

<sup>6</sup>The Mineralogical Record. Durangite From Utah. V. 17, No. 5, Sept.-Oct. 1986, p. 342.

<sup>7</sup>Farr, P. Beryllium. Mining Annual Review, 1986. Min. J. (London), 1986, p. 90.

<sup>8</sup>American Metal Market. Mar. 20, 1987, p. 5.

<sup>9</sup>Musto Explorations Ltd. 1986 Annual Report. P. 6.

<sup>10</sup>Rocky Mountain Pay Dirt. Mercur Sets Production Record of 111,007 Ounces During 1986. No. 91, Apr. 1987, p. 21A.

<sup>11</sup>Skilling's Mining Review. V. 76, No. 5, 1985, p. 9.

<sup>12</sup>Walenga, K. Umecro To Reopen Some Uranium Operations on Limited Basis. Rocky Mountain Pay Dirt, No. 89, Feb. 1987, p. 24A.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asphalt:</b> American Gilsonite Co., a subsidiary of Chevron Corp.	Kennecott Bldg., Suite 1150 Salt Lake City, UT 84133	Underground mines and plant.	Uintah.
<b>Beryllium:</b> Brush Wellman Inc.-----	67 West 2950 South Salt Lake City, UT 84115	Open pit mines and plant.-----	Juab and Millard.
<b>Cement:</b> Ideal Basic Industries Inc., Cement Div. <sup>1</sup>	Box 8789 Denver, CO 80201	Quarries and plant.-----	Morgan.
Portland Cement Co. of Utah, a division of Lone Star Industries Inc. <sup>1</sup>	Box 90765 Houston, TX 77290	-----do-----	Salt Lake and Tooele.
Southwestern Portland Cement Co., a subsidiary of Southdown Inc. <sup>1 2</sup>	Box 21158 Salt Lake City, UT 84121	-----do-----	Millard.
<b>Clays:</b> Interpace Corp., Structural Div.	736 West Harrisville Rd. Box 447 Ogden, UT 84402	Open pit mines and plant.---	Utah.
Interstate Brick Co., a subsidiary of Mountain Fuel Co.	9780 South 5200 West West Jordan, UT 84084	-----do-----	Box Elder, Tooele, Utah.
Utelite Corp.-----	Box 387 Coalville, UT 84017	Open pit mine and plant.---	Summit.
Western Clay Co. <sup>1</sup> -----	Box 1067 Aurora, UT 84620	Open pit mines.-----	Sevier.
<b>Copper:</b> Kennecott, Utah Copper Div. <sup>3</sup>	8362 West 10200 South Box 525 Bingham Canyon, UT 84006	Open pit mine, mills, smelter, refinery.	Salt Lake.
<b>Gold:</b> Barrick Mercur Gold Mines Inc., a subsidiary of American Barrick Resources Corp. <sup>4</sup>	Box 838 Tooele, UT 84074	Open pit mine, mill, carbon-in-pulp plant.	Tooele.
<b>Gypsum:</b> Georgia-Pacific Corp.-----	Box 80 Sigurd, UT 84657	Open pit mine and plant.---	Sevier.
United States Gypsum Co., a subsidiary of USG Corp.	Box 120 Sigurd, UT 84657	-----do-----	Do.
<b>Iron and steel:</b> Nucor Steel Div., Nucor Corp.	Box 100 Plymouth, UT 84330	Plant.-----	Box Elder.
USS Inc., a division of USX Corp. <sup>1</sup>	Geneva Works Box 510 Provo, UT 84603	Steel plants.-----	Iron and Uintah.
<b>Lime:</b> Continental Lime Inc., a subsidiary of Steel Bros. Canada Ltd. <sup>1</sup>	Box 266 Delta, UT 84624	Quarry and plant.-----	Millard.
Genstar Lime Co., a subsidiary of Chemstar Inc. <sup>1</sup>	Box 357 Grantsville, UT 84029	Open pit mine and plant.---	Tooele.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime—Continued			
Utah Marblehead Lime Co., a subsidiary of General Dynamics Corp. <sup>1</sup>	Box 596 Grantsville, UT 84029	Open pit mine and plant	Tooele.
Magnesium: AMAX Magnesium Corp., a subsidiary of AMAX Inc.	238 North 2200 West Salt Lake City, UT 84116	Plant and solar evaporation ponds.	Do.
Phosphate rock: Chevron Resources Co., a subsidiary of Chev- ron Corp.	Manila Star Route Vernal, UT 84078	Open pit mine and plant	Uintah.
Potassium salts: Great Salt Lake Minerals & Chemicals Corp., a division of Gulf Resources & Chem- icals Corp. <sup>5</sup>	765 North 10500 West Little Mountain Box 1190 Ogden, UT 84402	Plant, concentrator, solar evap- oration ponds.	Weber.
Kaiser Chemicals of Kaiser Aluminum & Chemical Corp., Bonneville Ltd. Div. <sup>6</sup>	Box 580 Wendover, UT 84083	-----do-----	Tooele.
Texasgulf Inc., a subsidiary of Société Nationale Elf Aquitaine. <sup>7</sup>	Box 1208 Moab, UT 84532	Solution mine, solar evapora- tion pond, concentrator, plant.	Grand.
Salt: American Salt Co.-----	Box 477 Grantsville, UT 84029	Plant-----	Tooele.
Morton Salt Co., a division of Morton-Thiokol Inc.	A.M.F. Box 22054 Salt Lake City, UT 84122	-----do-----	Salt Lake.
Sol-Aire Salt & Chemical Co	1428 Hardy Rd. Lake Point, UT 84074	-----do-----	Tooele.
Sand and gravel (construction): Concrete Products Co., a division of Gibbons & Reed Co. <sup>2</sup>	41 West Central Ave. Box 7356 Murray, UT 84107	Pits and plants-----	Davis, Salt Lake, Summit, Tooele, Utah, Weber, Salt Lake.
Geneva Rock Products Inc	1565 West 400 North Box 538 Orem, UT 84057	-----do-----	Salt Lake.
Harper Excavating Inc ---	4655 West 5415 South Kearns, UT 84118	-----do-----	Do.
Kiewit Western Co -----	5900 South 370 West Box 7780 Murray, UT 84107	-----do-----	Do.
LeGrand Johnson Construc- tion Inc.	Box 248 Logan, UT 84321	-----do-----	Cache, Juab, Rich.
Monroc Inc-----	1730 North Beck St. Box 537 Salt Lake City, UT 84110	-----do-----	Salt Lake.
Jack B. Parson Co. Inc ----	5200 South Washington Blvd. Box 3429 Ogden, UT 84402	-----do-----	Box Elder, Cache, Davis.
Pioneer Sand & Gravel Co.--	6000 West 5400 South Box 18457 Kearns, UT 84118	Pits and plant-----	Salt Lake.
Salt Lake Valley Sand & Gravel Co. <sup>3</sup>	300 North 1550 West Box E Sandy, UT 84070	-----do-----	Do.
Savage Rock Products ----	748 West 300 South Salt Lake City, UT 84104	Pits and plants-----	Davis and Salt Lake.
Silver: Hecla Mining Co., Escal- ante Unit. <sup>9</sup>	Box 308 Enterprise, UT 84725	Underground mine, mill, plant.	Iron.
Stone: Crushed: Diversified Marketing Services Inc.	Box 1181 Fillmore, UT 84631	Quarry and plant-----	Millard.
Lava Products Inc-----	94 West Tabernacle St. George, UT 84770	-----do-----	Washington.
McFarland & Hullinger	Box 238 Tooele, UT 84074	-----do-----	Tooele.
Southern Pacific Trans- portation Co.	One Market Pl. San Francisco, CA 94105	-----do-----	Box Elder.
Dimension: Star Stone Inc-----	Box 211 Oakley, ID 83346	-----do-----	Do.

See footnotes at end of table.

Table 9.—Principal producers—Continued

Commodity and company	Address	Type of activity	County
Vanadium:			
Atlas Corp., Atlas Minerals Div.	Box 1207 Moab, UT 84532	Underground mines and mill	Emery, Grand, San Juan.
Umetco Minerals Corp.-----	Box 669 Blanding, UT 84511	Underground mines, ore-buying station, research laboratory.	Emery, Garfield, San Juan.

<sup>1</sup>Also stone.<sup>2</sup>Also clays.<sup>3</sup>Also gold, molybdenum, and silver.<sup>4</sup>Also silver.<sup>5</sup>Also magnesium compounds, salt, and sodium sulfate.<sup>6</sup>Also magnesium compounds.<sup>7</sup>Also salt.<sup>8</sup>Also industrial sand.<sup>9</sup>Also gold.

# The Mineral Industry of Vermont

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

By Donald K. Harrison<sup>1</sup> and Charles A. Ratté<sup>2</sup>

The value of nonfuel mineral production in Vermont in 1986 was \$55.2 million, a \$5.4 million increase over that of 1985. Asbestos, gem stones, dimension stone, and talc accounted for more than two-thirds of the State's total mineral value. Construction sand and gravel and crushed stone account-

ed for the remaining one-third.

Nationally, the State ranked third among the nine States that produced talc. It also ranked third in quantity of dimension stone production and first in value. Vermont was one of only two States that produced asbestos.

Table 1.—Nonfuel mineral production in Vermont<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel (construction) thousand short tons..	3,802	\$8,071	<sup>e</sup> 2,700	<sup>e</sup> \$7,000	4,834	\$11,226
Stone:						
Crushed.....do.....	<sup>e</sup> 1,800	<sup>e</sup> 7,000	1,689	7,468	<sup>e</sup> 1,600	<sup>e</sup> 7,600
Dimension.....do.....	<sup>r</sup> <sup>e</sup> 111	<sup>r</sup> <sup>e</sup> 23,963	116	26,346	<sup>e</sup> 105	<sup>e</sup> 27,075
Combined value of asbestos, gem stones, and talc and pyrophyllite .....	XX	9,565	XX	9,040	XX	9,310
Total.....	XX	<sup>r</sup> 48,599	XX	49,854	XX	55,211

<sup>e</sup>Estimated. <sup>r</sup>Revised. XX Not applicable.

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

**Table 2.—Nonfuel minerals produced in Vermont in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Addison -----	Stone (crushed).
Caledonia -----	Stone (crushed), stone (dimension).
Chittenden -----	Stone (crushed).
Lamoille -----	Do.
Orange -----	Stone (dimension).
Orleans -----	Asbestos.
Rutland -----	Stone (dimension), stone (crushed).
Washington -----	Do.
Windham -----	Talc.
Windsor -----	Talc, stone (dimension), stone (crushed).
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Table 3.—Indicators of Vermont business activity**

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population -----	thousands	530	535	541
Total civilian labor force -----	do	269	278	292
Unemployment -----	percent	5.2	4.8	4.7
<b>Employment (nonagricultural):</b>				
Mining total -----	thousands	0.5	0.5	0.5
Manufacturing total -----	do	49.0	49.8	49.6
Stone, clay, and glass products -----	do	2.1	2.3	2.3
Chemicals and allied products <sup>1</sup> -----	do	.8	.8	.8
Construction -----	do	12.2	13.8	15.1
Transportation and public utilities -----	do	9.2	9.4	9.7
Wholesale and retail trade -----	do	46.9	50.0	52.5
Finance, insurance, real estate -----	do	9.3	10.1	11.0
Services -----	do	51.3	53.7	57.0
Government and government enterprises -----	do	36.5	37.4	38.4
<b>Total</b> -----	do	214.9	224.7	<sup>2</sup> 233.7
<b>Personal income:</b>				
Total -----	millions	\$6,116	\$6,645	\$7,220
Per capita -----		\$11,538	\$12,415	\$13,348
<b>Hours and earnings:</b>				
Total average weekly hours, production workers -----		40.6	40.7	40.7
Total average hourly earnings, production workers -----		\$8.0	\$8.4	\$8.8
<b>Earnings by industry:<sup>3</sup></b>				
Farm income -----	millions	\$103	\$117	\$124
Nonfarm -----	do	\$4,153	\$4,562	\$5,012
Mining total -----	do	\$24	\$30	\$31
Manufacturing total -----	do	\$1,143	\$1,224	\$1,294
Primary metal industries -----	do	\$18	\$18	\$19
Stone, clay, and glass products -----	do	\$49	\$55	\$62
Chemicals and allied products -----	do	\$16	\$16	\$17
Construction -----	do	\$334	\$396	\$458
Transportation and public utilities -----	do	\$266	\$279	\$293
Wholesale and retail trade -----	do	\$660	\$740	\$807
Finance, insurance, real estate -----	do	\$174	\$199	\$254
Services -----	do	\$912	\$1,008	\$1,142
Government and government enterprises -----	do	\$611	\$659	\$704
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup> -----		3,930	4,161	4,478
Value of nonresidential construction <sup>4</sup> -----	millions	\$143.2	\$160.7	\$171.8
Value of State road contract awards <sup>5</sup> -----	do	\$42.5	\$68.5	\$74.0
Shipments of portland and masonry cement to and within the State <sup>6</sup> -----	thousand short tons	149	216	177
<b>Nonfuel mineral production value:</b>				
Total crude mineral value -----	millions	\$48.6	\$49.9	\$55.2
Value per capita -----		\$92	\$93	\$102

<sup>F</sup>Preliminary. <sup>P</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data do not add to total shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

<sup>6</sup>Has no cement-producing plants.

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

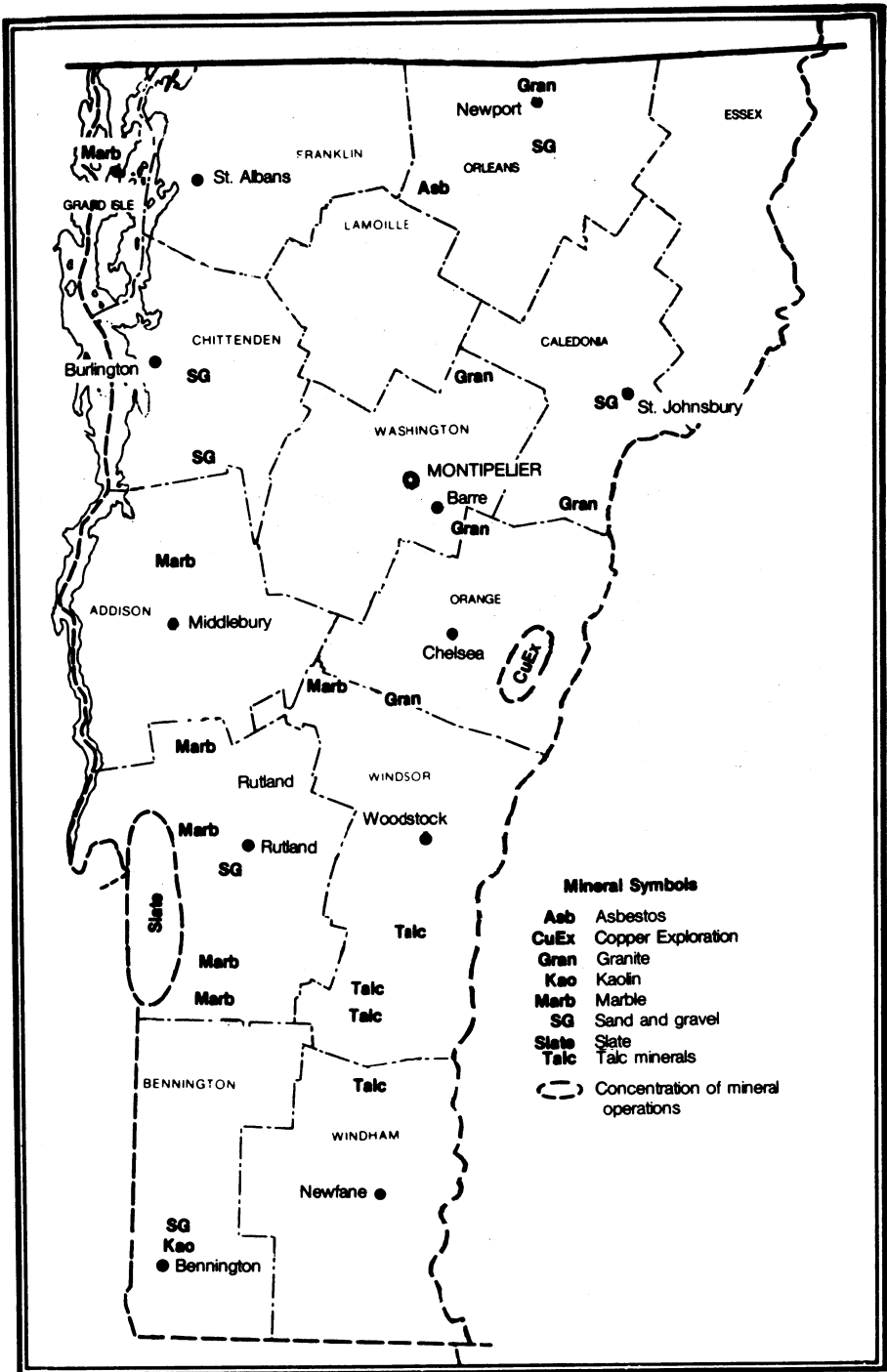


Figure 1.—Principal mineral-producing localities in Vermont.

**Legislation and Government Programs.**—Act 199, Senate bill 42, established standards for indirect discharge of wastes into streams or other waters (including ground water). The act will affect extractive mining operations that remove water from a mine or use ground water for processing. Act 195, House bill 750, established an Advisory Commission on Low-Level Radioactive Waste. The Commission is required to develop a management plan for low-level radioactive waste generated within the State's borders.

The Economic Development Council of Northern Vermont and the Northeast Training Organization received a grant from the Vermont Department of Employment and Training Organization to set up a

job retraining program for displaced asbestos and talc mine workers in the State's northern tier. It was estimated that nearly 300 miners were displaced in the counties of Caledonia, Essex, Franklin, Grand Isle, Lamoille, and Orleans. In 1983, an underground talc mine in Johnson, Lamoille County, was closed, and an asbestos mine in Lowell, Orleans County, was shut down for more than 6 months in 1986.

The Office of the State Geologist, Agency of Environmental Conservation, completed data gathering on both metallic and industrial mineral resources to be placed in the U.S. Geological Survey's computerized Mineral Resources Data System; a proposal to include sand and gravel resources was approved.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Asbestos.**—The Vermont Asbestos Group Inc. produced chrysotile asbestos from an open pit mine and operated a 35,000-short-ton-per-year-capacity mill at Lowell, Orleans County. The company, which mined intermittently during the year, produced a wide range of chrysotile grades—H1, H2, and groups 4, 5, 6, and 7—for worldwide use in a number of applications. The asbestos was sold both domestically and overseas for use in the manufacture of asbestos cement, brake linings, chlorine diaphragms, fiber boards, gaskets, and roofing felt.<sup>3</sup>

Shipments of asbestos continued to decline in 1986, the result of publicity on asbestos-related health risks and a proposed U.S. Environmental Protection Agency

(EPA) ban of certain asbestos products.<sup>4</sup> The EPA proposal called for an immediate halt on the use of five product categories containing asbestos and suggested that all other asbestos use be phased out over the next 10 years. In addition, the U.S. Occupational Safety and Health Administration (OSHA) enacted a ruling that limited worker exposure to 0.2 fiber per cubic centimeter per 8-hour work period.<sup>5</sup>

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Table 4.—Vermont: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	495	\$1,922	\$3.88
Plaster and gunitite sands -----	W	W	4.43
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	38	154	4.05
Asphaltic concrete aggregates and other bituminous mixtures -----	154	417	2.71
Road base and coverings -----	884	1,631	1.85
Fill -----	245	326	1.33
Snow and ice control -----	132	248	1.88
Railroad ballast -----	7	12	1.71
Other -----	76	161	2.12
Other unspecified <sup>1</sup> -----	2,802	6,356	2.27
Total <sup>2</sup> or average -----	4,834	11,226	2.32

<sup>1</sup>W Withheld to avoid disclosing company proprietary data; included with "Other."

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Limestone was the leading type produced, followed by granite and marble. Major uses were for bituminous concrete and road base aggregates.

Cyprus Mines Co., a subsidiary of Standard Oil of Indiana-Amoco Minerals Co., received an Act 250 land use permit to reopen a marble quarry in Brandon, Rutland County. The company also installed a rock-crushing plant at the 120-acre site.

**Dimension.**—Dimension stone was the State's leading mineral commodity, accounting for nearly 50% of the State's total value. Nationally, the State ranked third in output but first in value. In 1985, 16 quarries were operated in 5 counties in the State. Leading counties in order of output were Washington, Rutland, and Caledonia. Most of the production was granite, followed by slate and marble.

In May, Rock of Ages Corp. purchased the Wells-Lamson Quarry Co., giving Rock of Ages sole ownership of all the operating dimension granite quarries in the Barre area. Included in the sale were Wells-Lamson's quarry and adjoining saw plant in the Lower Websterville section of Barre Town, and all related machinery and equipment for quarrying, transporting, and processing the stone.

**Talc.**—Nationally, Vermont ranked third in talc production after Montana and Texas. Both production and value rose slightly in 1986. Primary uses for the talc were as a filler-extender in cosmetics, building materials, and plastics.

In August, Vermont Talc Co. completed a 3-month exploratory drilling program on a 600-acre tract near Troy. Drilling indicated that the property contained large reserves of asbestos-free talc. In October, Vermont Talc received local approval to develop the mine. However, the company must also receive permits under the State's land and water use acts, which were pending at yearend. Vermont Talc was expected to supply its mill in Johnson, about 25 miles from Troy, with talc from the new mine. Last year, Vermont Talc merged with Acqui-Tal Inc., which had operated the Johnson mill since 1984. Acqui-Tal had upgraded the mill during the past 2 years, doubling its capacity and allowing for production of cosmetic-grade talc. Acqui-Tal had purchased talc from Vermont Talc's mine in Windham, about 140 miles from Johnson.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>State geologist, Agency of Environmental Conservation, Waterbury, VT.

<sup>3</sup>Asbestos Raising in East But Setting in West. Industrial Minerals No. 223, Apr. 1986, p. 27.

<sup>4</sup>Federal Register. U.S. Environmental Protection Agency. Asbestos: Proposed Mining and Import Restrictions and Proposed Manufacturing, Importation, and Processing Prohibitions. V. 51, No. 19, Jan. 29, 1986, pp. 3739-3759.

<sup>5</sup>Federal Register. U.S. Occupational Safety and Health Administration. Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules. V. 51, No. 119, June 20, 1986, pp. 22612-22790.



Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Asbestos:</b>			
Vermont Asbestos Group Inc -----	Box 54B Morrisville, VT 05661	Pit -----	Orleans.
<b>Sand and gravel (construction):</b>			
Calkins Sand & Gravel Inc -----	Box 82 Lyndonville, VT 05851	Pits and plant	Caledonia and Orleans.
Joseph P. Carrara & Sons Inc -----	Route 116 Middlebury, VT 05753	Pits -----	Addison and Rutland.
William E. Daily Inc -----	Route 1, Box 51 Shaftsbury, VT 05262	-----do -----	Bennington.
Hinesburg Sand & Gravel Co -----	Box 200 Hinesburg, VT 05461	-----do -----	Chittenden.
Ormond Bushey & Sons Inc -----	Box 183 Fairfax, VT 05454	Pits -----	Chittenden and Franklin.
Frank W. Whitcomb Construction Corp --	Box 429 Bellows Falls, VT 05101	Pit and plant	Rutland.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
Cooley Asphalt Paving Corp -----	Box 542 Barre, VT 05641	Quarry -----	Washington.
Pike Industries Inc -----	Route 3, Box 91 Tilton, NH 03276	-----do -----	Caledonia.
Frank W. Whitcomb Construction Corp.	Box 29 Bellows Falls, VT 05101	Quarries ---	Chittenden.
White Pigment Corp -----	Florence, VT 05744 -----	-----do -----	Addison and Rutland.
<b>Dimension:</b>			
OMYA Inc -----	61 Main St. Proctor, VT 05765	Quarry and plant.	Rutland and Windsor.
Rock of Ages Corp., a subsidiary of John Swenson Granite Co. Inc.	Box 482 Barre, VT 05641	Quarries ---	Washington and Windsor.
John Swenson Granite Co. Inc -----	North State St. Concord, NH 03301	Quarry -----	Washington.
<b>Talc:</b>			
Vermont Talc Co., a subsidiary of OMYA Inc.	Route 11, Box 117 Chester, VT 05143	Mine and mill	Windham.
Windsor Minerals Inc -----	Box 680 Windsor, VT 05089	Mines and mills.	Windsor.

# The Mineral Industry of Virginia

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

By L. J. Prosser, Jr.,<sup>1</sup> and Palmer C. Sweet<sup>2</sup>

In 1986, nonfuel mineral production in Virginia increased for the fourth consecutive year totaling \$393 million for a State record. Demand remained strong and stable for the second year in a row for the 13 commodities produced in the State.

Crushed stone, the leading nonfuel commodity in tonnage and value, was produced at an all-time high level in 1985 and again

in 1986. Nationally, Virginia ranked fifth in output of crushed stone.

Coal was also important to the State's economy as an industry itself as well as a source of fuel for the mining, manufacturing, and construction industries. Virginia was the seventh leading producer of coal in the United States.

Table 1.—Nonfuel mineral production in Virginia<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons...	712	\$6,004	814	\$6,977	890	\$7,700
Gem stones-----	NA	<sup>e</sup> 20	NA	<sup>e</sup> 20	NA	20
Iron oxide pigments (crude)--- short tons...	W	W	<sup>r</sup> 2,280	W	W	W
Lime ----- thousand short tons...	562	24,799	633	28,103	624	27,362
Sand and gravel (construction) --- do.---	8,860	37,359	<sup>e</sup> 10,200	<sup>e</sup> 42,000	11,670	46,488
Stone:						
Crushed----- do.---	<sup>e</sup> 47,200	<sup>e</sup> 196,000	51,686	221,900	<sup>e</sup> 52,000	<sup>e</sup> 224,700
Dimension----- do.---	<sup>r</sup> <sup>e</sup> 10	<sup>r</sup> <sup>e</sup> 3,066	10	3,136	<sup>e</sup> 10	<sup>e</sup> 3,128
Combined value of aplite, cement, gypsum, kyanite, sand and gravel (industrial), talc (soapstone, 1984-85), vermiculite, and values indicated by symbol W	XX	74,355	XX	79,140	XX	83,639
Total -----	XX	<sup>r</sup> 341,603	XX	381,276	XX	393,037

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

Table 2.—Nonfuel minerals produced in Virginia in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Albemarle	Stone (crushed).
Appomattox	Do.
Augusta	Do.
Bath	Do.
Bedford	Do.
Bland	Do.
Botetourt	Cement, stone (crushed), clays.
Brunswick	Stone (crushed).
Buckingham	Kyanite, stone (dimension), stone (crushed).
Campbell	Stone (crushed).
Caroline	Do.
Carroll	Do.
Chesterfield	Stone (crushed), clays.
Clarke	Stone (crushed).
Culpeper	Stone (crushed), stone (dimension).
Dinwiddie	Stone (crushed).
Fairfax	Do.
Fauquier	Stone (crushed), stone (dimension).
Franklin	Talc.
Frederick	Stone (crushed), sand (industrial), lime.
Giles	Lime, stone (crushed).
Goochland	Stone (crushed).
Grayson	Do.
Greensville	Do.
Halifax	Do.
Hanover	Stone (crushed), aplite, stone (dimension).
Henrico	Stone (crushed).
Henry	Do.
King and Queen	Clays.
Lee	Stone (crushed).
Loudoun	Do.
Louisa	Vermiculite, stone (crushed).
Madison	Clays.
Montgomery	Stone (crushed), clays.
Nelson	Stone (crushed).
Nottoway	Do.
Orange	Stone (crushed), clays.
Pittsylvania	Do.
Prince William	Do.
Pulaski	Iron oxide pigments.
Richmond (city)	Stone (crushed).
Roanoke	Stone (crushed), clays.
Rockbridge	Do.
Rockingham	Stone (crushed).
Russell	Do.
Scott	Do.
Shenandoah	Lime, stone (crushed).
Smyth	Gypsum, clays.
Spotsylvania	Stone (crushed).
Stafford	Do.
Tazewell	Stone (crushed), clays.
Virginia Beach (city)	Sand (industrial).
Warren	Lime, cement, stone (crushed).
Washington	Stone (crushed).
Wise	Do.
Wythe	Stone (crushed), iron oxide pigments.
Undistributed <sup>2</sup>	Sand and gravel (construction), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Virginia business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population	5,636	5,702	5,787
Total civilian labor force	2,840	2,857	2,885
Unemployment	5.0	5.6	5.0
<b>Employment (nonagricultural):</b>			
Mining total	18.3	17.3	16.4
Nonmetallic minerals except fuels <sup>1</sup>	2.4	2.5	2.7
Coal mining	15.5	14.5	13.5
Manufacturing total	421.3	423.4	424.2
Primary metal industries	10.9	10.8	10.7
Stone, clay, and glass products	13.5	14.4	15.3
Chemicals and allied products	32.6	32.1	32.6
Construction	132.8	152.0	168.1
Transportation and public utilities	127.2	132.0	137.3
Wholesale and retail trade	516.5	547.0	580.2
Finance, insurance, real estate	117.1	122.8	130.8
Services	495.1	544.7	579.0
Government and government enterprises	505.0	515.6	521.0
Total <sup>2</sup>	2,333.3	2,454.7	2,557.1
<b>Personal income:</b>			
Total	\$76,072	\$82,550	\$89,169
Per capita	\$13,498	\$14,477	\$15,408
<b>Hours and earnings:</b>			
Total average weekly hours, production workers	40.3	40.1	40.4
Total average hourly earnings, production workers	\$8.1	\$8.5	\$8.8
<b>Earnings by industry:<sup>3</sup></b>			
Farm income	\$452	\$331	\$360
Nonfarm	\$53,054	\$58,262	\$63,609
Mining total	\$807	\$847	\$824
Metal mining	\$5	\$6	\$3
Nonmetallic minerals except fuels	\$56	\$62	\$62
Coal mining	\$649	\$635	\$607
Oil and gas extraction	\$97	\$145	\$152
Manufacturing total	\$9,423	\$9,942	\$10,479
Primary metal industries	\$349	\$345	\$352
Stone, clay, and glass products	\$287	\$316	\$357
Chemicals and allied products	\$1,020	\$1,045	\$1,088
Petroleum and coal products	\$17	\$17	\$19
Construction	\$3,465	\$4,080	\$4,800
Transportation and public utilities	\$3,964	\$4,238	\$4,543
Wholesale and retail trade	\$7,911	\$8,643	\$9,560
Finance, insurance, real estate	\$2,443	\$2,768	\$3,289
Services	\$10,696	\$12,264	\$13,740
Government and government enterprises	\$14,162	\$15,255	\$16,108
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup>	60,348	64,120	73,511
Value of nonresidential construction <sup>4</sup>	\$1,841.6	\$2,058.9	\$2,570.7
Value of State road contract awards <sup>5</sup>	\$773.0	\$575.0	\$733.0
Shipments of portland and masonry cement to and within the State	2,112	2,293	2,629
thousand short tons			
<b>Nonfuel mineral production value:</b>			
Total crude mineral value	\$341.6	\$381.3	\$393.0
Value per capita	\$61	\$67	\$68

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

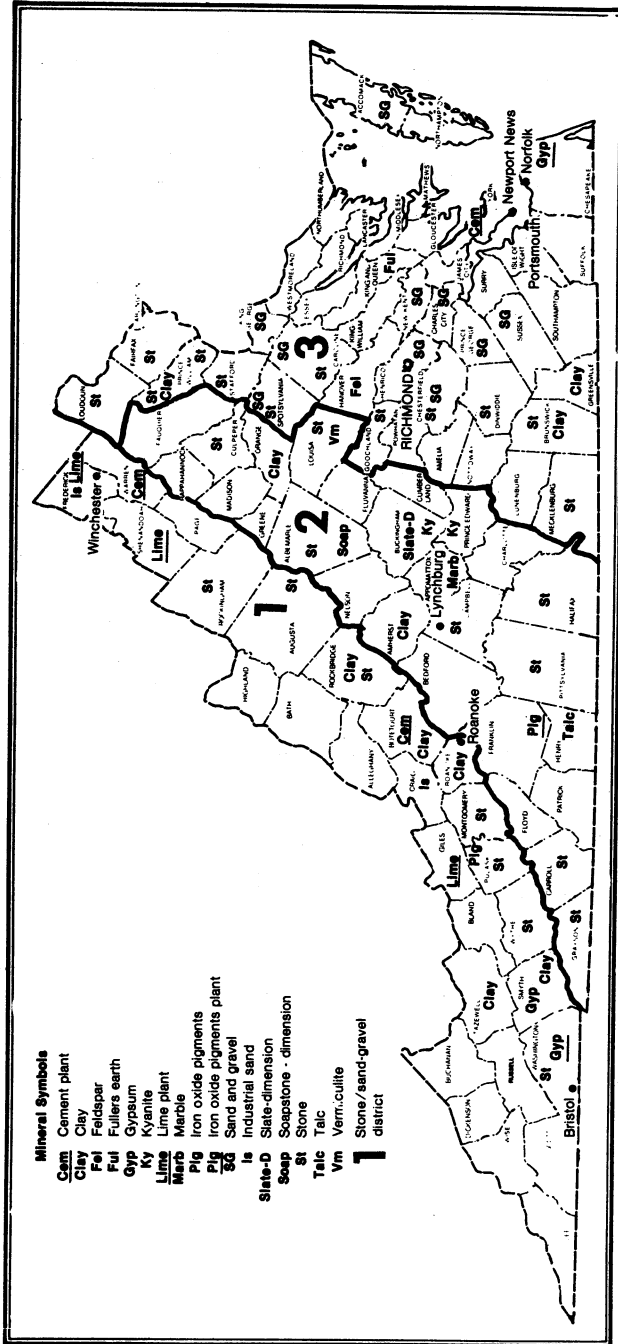


Figure 1.—Principal mineral-producing localities in Virginia.

**Trends and Developments.**—Most of the value of Virginia's nonfuel mineral industry came from production of crushed stone, a high-volume, low-cost commodity used extensively in construction. Since 1979, the value of crushed stone has accounted for \$1.4 billion or 56% of Virginia's total nonfuel mineral value of \$2.5 billion. In the 1980's, as demand from the construction industry changed, the fluctuations in the State's value of mineral production were less pronounced than expected because stone prices tended to remain stable during the periods of high production while increasing when output declined.

As demand from the construction industry began to decrease in 1980, the value of

mineral production also dropped. By 1982, the value had decreased by about \$47 million from \$310 million in 1979. That decline occurred despite a 25% or \$0.81-per-short-ton increase in the price of crushed stone from 1979 to 1982.

In 1984, the value of nonfuel mineral production increased by \$52 million over that of 1983 and, in 1985, another \$40 million gain in value over the 1984 total was reported. During this period (from 1983 to 1985), production of crushed stone increased 14 million short tons and the price increased only \$0.11 per ton.

Mineral fuels production for the last 5 years, as reported by the Virginia Division of Mineral Resources, was as follows:

	1982	1983	1984	1985	1986
Coal _____ million short tons _____	40.5	35.5	41.4	44.3	42.1
Natural gas _____ million cubic feet _____	6,880	4,347	8,928	15,041	15,427
Petroleum _____ barrels _____	49,425	65,443	32,840	26,654	18,342

The combined value of this sector of Virginia's mineral industry was about \$1.5 billion, with coal accounting for more than 95% of the total.

Traditionally, the Virginia coal industry has produced primarily metallurgical coal for use by the steel industry to make coke for reduction of iron ore in blast furnaces. Virginia's premium low-volatile coal was used worldwide. Together with new blast furnace and other steelmaking technology, depressed production has reduced the requirements for premium coking coal, stagnating the market and reducing world demand by 50%. The Virginia coal industry must expand its share of the steam and industrial coal markets.<sup>3</sup>

**Legislation and Government Programs.**—The Virginia Division of Mineral Resources, Department of Mines, Minerals and Energy, conducted studies of potential, operational, and abandoned mineral deposits and energy resources. Published in 1986

were reports on high-silica resources, an analysis of clay samples, and an assessment of heavy minerals of the Virginia inner Continental Shelf.<sup>4</sup>

Projects in progress included an investigation of carbonate rocks, the preparation of a State energy map, an offshore heavy minerals study, exploratory drilling for mineral-resource investigations in Campbell and Powhatan Counties, and cooperative studies with the U.S. Geological Survey on an assessment of coal resources in Virginia and a mineral-resource data system.

Virginia Polytechnic Institute and State University's Mining and Mineral Resources and Research Institute received a \$142,000 grant from the U.S. Bureau of Mines under the second year of Public Law 98-409. The school was also an affiliate of the University of Utah, one of the five generic mineral technology centers in the United States with expertise in the area of comminution (crushing and grinding).

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Aplite.**—Aplite is a feldspar mineral that is produced only in Virginia. This commodity is frequently called Virginia aplite. The term developed because rail tariffs were lower for aplite than for feldspar. The aplite was mined in Hanover County and sold to glass manufacturers.

**Cement.**—Tarmac PLC, a construction company in the United Kingdom, acquired a 60% interest in Lone Star Industries Inc.'s operations in Virginia and two other southeastern States. Lone Star was the State's leading cement producer. Nationally, about 49% of U.S. cement capacity was in foreign ownership. The U.S. Bureau of Mines reported "the most fundamental reason be-

hind the growth in foreign investment in the U.S. mineral industries (particularly since 1981) has been that an increasing proportion of U.S. mineral firms and assets have been for sale while foreign mineral companies have been the ones most willing and able to purchase these firms and/or their assets."<sup>5</sup>

Portland cement production in Virginia was combined with that produced in Kentucky and West Virginia to provide more information while avoiding disclosure of company proprietary data. In 1986, the three States, each with one plant operating, produced 2.6 million short tons of portland cement utilizing 93.2% of capacity.

Masonry cement data was also combined for the same reason, and the three States produced 294,000 tons. Virginia produced masonry cement at two plants; Kentucky and West Virginia, one each. Nationally, Virginia ranked ninth in masonry cement output.

Clays.—Output increased for the second consecutive year reflecting strong demand from the construction industry, particularly in homebuilding. In Virginia, the number of housing units in 1986, nearly 73,000, was 14% higher than in 1985 and almost 43,000 units more than in 1982. In 1982, a decade low of 422,000 short tons of clay was produced; output in 1985 and 1986 averaged more than twice that amount.

**Table 4.—Virginia: Clays sold or used by producers**

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1982	422	\$2,237
1983	784	5,467
1984	712	6,004
1985	814	6,977
1986	890	7,700

About four-fifths of the clay mined was used in brick manufacture, the remainder for concrete block, as an absorbent for pet waste, lightweight aggregate, and road surfacing. Fuller's earth was the absorbent; common clay was required for the other end uses.

**Gypsum.**—USG Corp., Virginia's only producer of crude gypsum, continued operations at its Locust Cove Mine in Smyth County. The company also manufactured gypsum wallboard at a plant in Norfolk using imported gypsum. USG was the leading domestic producer of gypsum with 12 mines nationwide.

**Kyanite.**—Virginia again led the Nation in kyanite production with one company operating two of the three mines in the United States. Because only two companies mined kyanite and the inherent competition resulting from this situation, output was not reported. Production was estimated to be lower in 1986, primarily because of a decline in steel shipments; that industry was the largest consumer of kyanite as used in refractories. Also, the Nation's other kyanite producer permanently shut down its mine in Georgia in September.

**Lime.**—Unlike most commodities produced in Virginia, output of lime failed to return to the levels reported in the late 1970's. Since that period, lime consumed by the steel industry has declined sharply as has steel production. In 1986, about 14% of Virginia's lime was used in making steel in basic oxygen furnaces (BOF). From 1977 through 1979, about 36% of the State's lime was consumed in BOF steel production.

The State's lime industry was the subject of a "Virginia Minerals" publication,<sup>6</sup> in which uses, geology, potential resources, and producers of lime were described in detail.

**Table 5.—Virginia: Lime sold or used by producers, by use**

Use	1985		1986	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace	89,314	\$3,967	89,808	\$3,894
Other <sup>1</sup>	543,386	24,136	533,819	23,468
Total	632,700	28,103	623,627	27,362

<sup>1</sup>Includes acid water (neutralization), alkalies, calcium aluminate cement, chrome, citric acid, fertilizer, insecticides, insulation, other chemical and industrial uses, other metallurgy, paint, paper and pulp, road stabilization, soil stabilization, steel (electric), sugar refining, and water purification.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Production of 11.7 million short tons of construction sand and gravel was the second highest total in State history. Demand for sand and gravel paralleled that of conditions in the construction industry. During

the last period of strong building growth and expansion, from 1977 through 1979, Virginia produced an average of 11.2 million tons of sand and gravel per year. From 1980 through 1983, when high interest rates adversely affected the construction industry, annual production averaged 7.4 million tons. Beginning in 1984 and reflecting lower interest rates along with increased funding for road construction and maintenance, sand and gravel production averaged 10.2 million tons through 1986.

**Table 6.—Virginia: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	5,021	\$27,409	\$5.46
Plaster and gunite sands -----	194	927	4.78
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	674	3,608	5.35
Asphaltic concrete aggregates and other bituminous mixtures -----	969	4,592	4.74
Road base and coverings <sup>1</sup> -----	462	1,944	4.21
Fill -----	2,150	3,029	1.41
Snow and ice control -----	119	415	3.49
Railroad ballast -----	W	W	3.43
Other <sup>2</sup> -----	233	961	4.12
Other unspecified <sup>3</sup> -----	1,848	3,603	1.95
<b>Total or average -----</b>	<b>11,670</b>	<b>46,488</b>	<b>3.98</b>

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes roofing granules and data indicated by symbol W.

<sup>3</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Table 7.—Virginia: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3	
	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates (including concrete sand) <sup>1</sup> -----	164	829	4	13	5,721	31,102
Asphaltic concrete aggregates and other bituminous mixtures <sup>2</sup> -----	W	W	W	W	1,297	5,969
Fill -----	56	193	2	5	2,092	2,831
Snow and ice control -----	W	W	W	W	117	406
Other unspecified <sup>3</sup> -----	378	1,632	155	476	1,684	3,032
<b>Total<sup>4</sup> -----</b>	<b>599</b>	<b>2,654</b>	<b>160</b>	<b>493</b>	<b>10,911</b>	<b>43,340</b>

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

<sup>1</sup>Includes plaster and gunite sands and concrete products (blocks, bricks, pipe, decorative, etc.).

<sup>2</sup>Includes road and other stabilization (cement and lime) and road base and coverings.

<sup>3</sup>Includes railroad ballast, roofing granules, production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Two companies produced industrial sand mostly for use in glass manufacture.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered

years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—Output of 52 million short tons



was the highest in State history and the second consecutive year of record-setting production. The value of crushed stone production of \$225 million was approximately three-fifths of the State's total value of nonfuel mineral output. The importance of this commodity to the State's economy is illustrated in table 3. In all construction activity categories, sharp increases were reported in 1985 and improved upon in 1986 except for a deviation in State road contract awards in 1985.

Along with the increased production and demand for crushed stone came increased environmental concerns. In 1986, attempts by aggregate producers to open or expand mining operations were subjected to local opposition and usually involved zoning regulations. The price per ton of crushed stone in Virginia in 1986 was \$4.32 compared with \$4.16 nationally. During the year, Vulcan Materials Co. shelved plans for a new quarry at a 1,200-acre site in Gainesville, Prince William County. Local officials believed that a quarry would deter economic development in the area.

*Dimension.*—Granite, limestone, sandstone, and slate were quarried for dimension stone at eight sites, primarily in central Virginia. Slate, the principal type quarried, was used for roofing.

**Talc (Soapstone).**—Suomen Vuolukivi Oy (Finnish Soapstone Inc.) purchased the Alberene Stone Co. in Schuyler, Nelson County. Alberene Stone had closed in 1973. The company was renamed the New Alberene Stone Co. and was expected to begin production early in 1987. Initially, the firm plans to use the soapstone to manufacture fireplaces. No talc production was reported in 1986.

**Vermiculite.**—Virginia was one of four

States that mined crude vermiculite. The vermiculite was sold in unexfoliated form to North Carolina, Ohio, West Virginia, and other Eastern States. Uses of the material, when exfoliated, included packing, insulation, and as potting material. Individual State and company totals are proprietary; domestic production totaled 317,000 short tons.

## METALS

**Iron Oxide Pigments.**—Nationally, about 41,000 short tons of crude iron oxide pigments was shipped, with Virginia's output the lowest among four producing States. Pigments were used in printing inks, paint manufacture, and as coloring agents in other products.

**Iron and Steel.**—Two companies operated minimills in the State. In August, Birmingham Steel Corp. purchased Intercoastal Steel Corp. for \$6.5 million and renamed the operation Norfolk Steel Corp. The mill has an annual capacity of 175,000 short tons but produced less than one-half that amount in 1986.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Pittsburgh, PA.

<sup>2</sup>Head geologist, Economic Geology Section, Virginia Division of Mineral Resources.

<sup>3</sup>Hibbard, W. R., Jr. The Virginia Coal Industry: A Study of Utility Markets. VA Center for Coal and Energy Res., VA Polytech. Inst. and State Univ., Blacksburg, VA, May 28, 1986, 20 pp.

<sup>4</sup>Sweet, P. C., and G. P. Wilkes. High-Silica Resources in Alleghany, Botetourt, Craig, and Roanoke Counties, Virginia. VA Div. Miner. Resour., Publ. 67, 1986, 35 pp.

Sweet, P. C. Clay—Material Samples Collected 1981-1984. VA Div. Miner. Resour., Publ. 68, 1986, 107 pp.

Berquist, C. R., and C. H. Hobbs. Assessment of Economic Heavy Minerals of the Virginia Inner Continental Shelf. VA Div. Miner. Resour., OFR 86-1, 1986, 17 pp.

<sup>5</sup>Sousa, L. J., E. H. Yarenchuk, and A. P. Graham. Foreign Direct Investment in the U.S. Minerals Industry. BuMines IC 9131, 1987, 24 pp.

<sup>6</sup>Sweet, P. C. Virginia's Lime Industry. VA Div. Miner. Resour. VA Miner., v. 32, No. 4., Nov. 1986, pp. 33-43.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aplite:</b>			
The Feldspar Corp -----	Route 1, Box 305 Montpelier, VA 23192	Quarry and plant	Hanover.
<b>Cement:</b>			
Lone Star Cement Inc. <sup>1</sup> -----	Box 27 Cloverdale, VA 24077	-----do-----	Botetourt.
Lone Star Lafarge Inc -----	Box 5128 Chesapeake, VA 23320	Plant -----	Chesapeake (city).
Riverton Corp. <sup>2</sup> -----	Box 4004 Front Royal, VA 22630	Quarry and plant	Warren.
<b>Clays:</b>			
Brick & Tile Corp -----	Box 45 Lawrenceville, VA 23868	Pits and plant---	Brunswick and Greensville.
General Shale Products Corp -----	Box 3547 Johnson City, TN 37601	-----do-----	Rockbridge and Smyth.
Webster Brick Co. Inc -----	Box 12887 Roanoke, VA 24029	-----do-----	Botetourt and Orange.
<b>Gypsum:</b>			
USG Corp -----	Box 4686 Norfolk, VA 23523	Plant -----	Norfolk (city).
Do -----	Route 1 Saltville, VA 24370	Mine and plant--	Smyth and Washington.
<b>Iron oxide pigments (crude):</b>			
Hoover Color Corp -----	Box 218 Hiwassee, VA 24347	-----do-----	Pulaski.
<b>Kyanite:</b>			
Kyanite Mining Corp -----	Dillwyn, VA 23936 -----	Mines and plants Plant -----	Buckingham. Prince Edward.
<b>Lime:</b>			
Chemstone Corp -----	Route 629, Box 71 Strasburg, VA 22657	Quarry and plant	Shenandoah.
USG Industries Inc -----	Star Route 635 Ripplemead, VA 24150	Underground mine and plant.	Giles.
<b>Sand and gravel (construction, 1985):</b>			
Fredericksburg Sand & Gravel Co.---	Box 650 Culpeper, VA 22701	Pit and plant ---	Stafford.
Solite Corp -----	Box 27211 Richmond, VA 23230	-----do-----	King George.
Tarmac-Lone Star Inc -----	Box 420 Norfolk, VA 23501	Pits and plants --	Charles City, Ches- terfield, Hen- rico, Prince George.
Williams Corp. of Virginia -----	Box 938 Norfolk, VA 23501	Pit and plant ---	Virginia Beach (city).
<b>Stone:</b>			
W. W. Boxley Co -----	Box 13527 Roanoke, VA 24034	Quarries -----	Bland, Botetourt, Campbell, Henry, Rich- mond (city), Tazewell.
Luck Stone Corp -----	Box 29682 Richmond, VA 23229	-----do-----	Albemarle, Augusta, Fairfax, Goochland, Greene, Halifax, Loudoun, Notto- way, Rocking- ham.
Vulcan Materials Co., Midsouth Div --	Box 7 Knoxville, TN 37901	-----do-----	Washington.
<b>Vermiculite:</b>			
Virginia Vermiculite Ltd -----	Box 70 Louisa, VA 23093	Mine and plant --	Louisa.

<sup>1</sup>Also stone.<sup>2</sup>Masonry cement only; also produces lime and limestone.



# The Mineral Industry of Washington

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

By W. L. Rice<sup>1</sup> and Nancy L. Joseph<sup>2</sup>

Washington's nonfuel mineral production value rose to \$376.6 million, a significant increase from the \$221.6 million reported in 1985. A first-time reporting of magnesium metal production from the State accounted for a substantial part of the increase; other important factors were a nearly tripled value for gold production and a sizable increase in the production value of construction sand and gravel.

Magnesium was the leading commodity in terms of value, followed by construction sand and gravel, gold, and portland cement. The industrial minerals—chiefly cement, clays, diatomite, lime, sand and gravel, and stone—accounted for only about 55% of the State's total nonfuel mineral value for the year, compared with 88% in 1985 and 94% in 1984. The apparent large decrease in the 1986 industrial mineral share of the State's

Table 1.—Nonfuel mineral production in Washington<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
<b>Cement:</b>						
Masonry ----- thousand short tons ..	W	W	W	W	6	\$530
Portland ----- do. ....	W	W	W	W	1,212	59,091
Clays ----- do. ....	<sup>2</sup> 292	<sup>2</sup> \$1,598	243	\$1,402	252	1,560
Gem stones ----- do. ....	NA	<sup>e</sup> 200	NA	<sup>e</sup> 200	NA	200
Peat ----- thousand short tons ..	W	W	12	292	W	W
<b>Sand and gravel:</b>						
Construction ----- do. ....	23,369	61,070	<sup>e</sup> 22,700	<sup>e</sup> 62,300	26,342	76,387
Industrial ----- do. ....	356	5,201	322	5,589	W	W
<b>Stone:</b>						
Crushed ----- do. ....	<sup>e</sup> 10,400	<sup>e</sup> 31,700	9,543	31,052	<sup>e</sup> 9,000	<sup>e</sup> 34,100
Dimension ----- do. ....	<sup>r</sup> e <sub>1</sub>	<sup>r</sup> e <sub>53</sub>	1	53	<sup>e</sup> 1	<sup>e</sup> 69
Combined value of barite (1984-85), calcium chloride (natural, 1985-86), clays (fire clay, 1984), diatomite, gold, gypsum, lime, magnesium metal <sup>3</sup> (1986), olivine, silver, talc and pyrophyllite (1984), and values indicated by symbol W -----	XX	102,855	XX	<sup>r</sup> 120,719	XX	204,688
<b>Total -----</b>	XX	<sup>r</sup> 202,677	XX	<sup>r</sup> 221,607	XX	376,625

<sup>e</sup>Estimated. <sup>r</sup>Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>2</sup>Excludes fire clay; value included with "Combined value" figure.

<sup>3</sup>Magnesium (refinery production) not reported in 1984 and 1985.

total nonfuel mineral production value was, again, primarily because of the first-time reporting of magnesium mineral production and a large increase in the value of gold production.

Washington ranked 21st in the Nation in the value of nonfuel minerals produced, up from the 31st ranking in 1985. The State ranked 27th in the value of industrial mineral production.

**Table 2.—Nonfuel minerals produced in Washington in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Asotin -----	Stone (crushed).
Benton -----	Do.
Chelan -----	Gold, silver, sand (industrial).
Clallam -----	Clays, stone (crushed).
Clark -----	Stone (crushed), clays.
Columbia -----	Stone (crushed).
Cowlitz -----	Stone (crushed), calcium chloride.
Douglas -----	Stone (crushed).
Ferry -----	Gold, stone (crushed), silver.
Franklin -----	Stone (crushed).
Garfield -----	Do.
Grant -----	Diatomite, stone (crushed).
Grays Harbor -----	Stone (crushed), peat.
Jefferson -----	Stone (crushed).
King -----	Cement, sand (industrial), stone (crushed), clays, peat.
Kitsap -----	Stone (crushed).
Kittitas -----	Do.
Klickitat -----	Do.
Lewis -----	Do.
Lincoln -----	Do.
Okanogan -----	Peat, stone (crushed), gypsum.
Pacific -----	Stone (crushed).
Pend Oreille -----	Cement, stone (crushed).
Pierce -----	Lime, stone (crushed), clays.
San Juan -----	Stone (crushed).
Skagit -----	Olivine, stone (crushed), stone (dimension).
Skamania -----	Stone (crushed).
Snohomish -----	Do.
Spokane -----	Do.
Stevens -----	Lime, sand (industrial), stone (crushed), barite, stone (dimension).
Thurston -----	Stone (crushed).
Wahkiakum -----	Do.
Whatcom -----	Cement, stone (crushed).
Whitman -----	Stone (crushed).
Yakima -----	Stone (crushed), stone (dimension).
Undistributed <sup>2</sup> -----	Sand and gravel (construction), stone (crushed), gem stones.

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

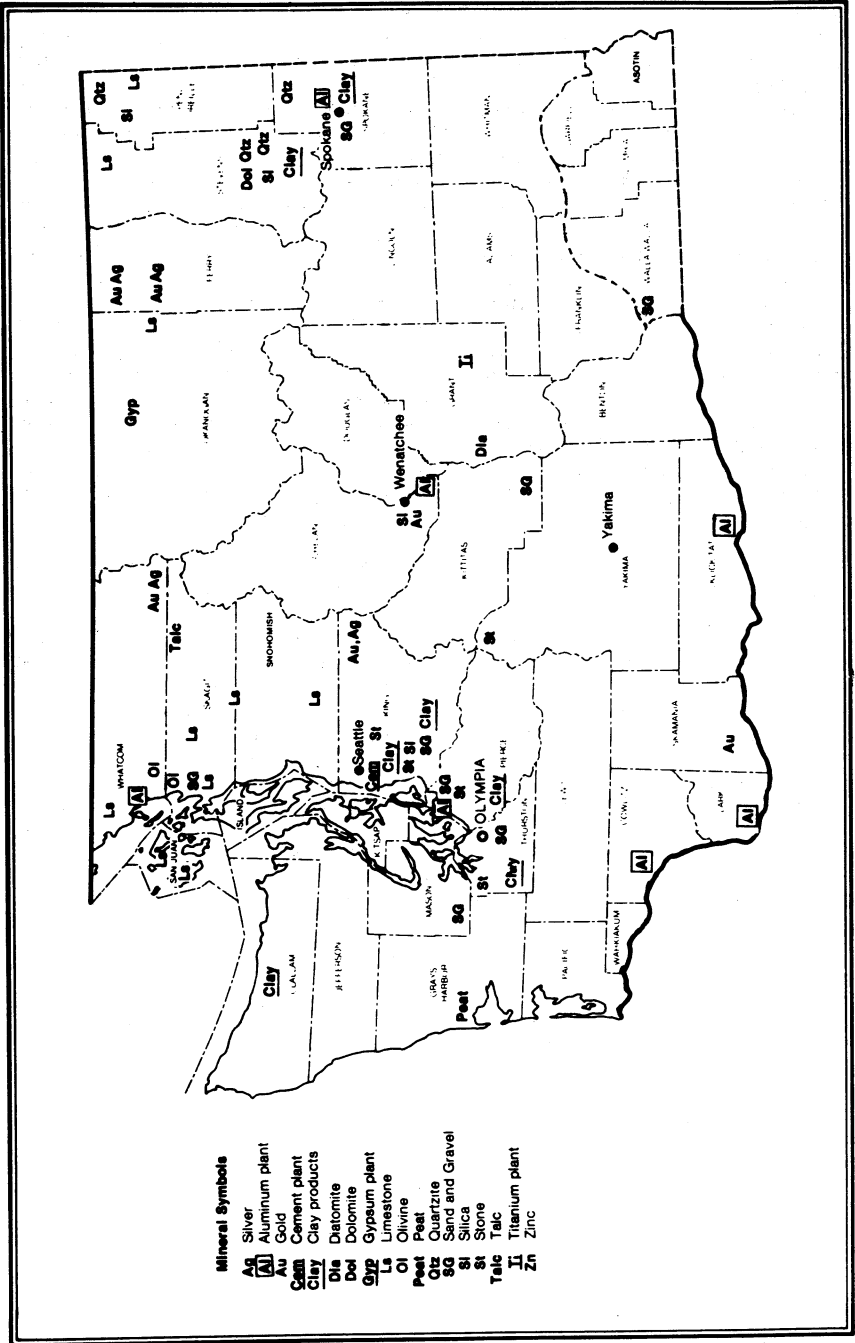
<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Washington business activity

	1984 <sup>T</sup>	1985	1986 <sup>P</sup>	
<b>Employment and labor force, annual average:</b>				
Population	thousands	4,350	4,408	4,462
Total civilian labor force	do.	2,054	2,087	2,178
Unemployment	percent	9.5	8.1	8.2
<b>Employment (nonagricultural):</b>				
Mining total	thousands	2.6	2.7	2.9
Metal mining <sup>1</sup>	do.	4	4	.4
Nonmetallic minerals except fuels <sup>1</sup>	do.	1.4	1.4	1.4
Manufacturing total	do.	288.1	295.6	304.2
Primary metal industries	do.	13.4	12.7	11.8
Stone, clay, and glass products	do.	6.5	6.4	6.3
Chemicals and allied products	do.	10.5	11.3	11.5
Petroleum and coal products <sup>2</sup>	do.	1.7	1.8	1.7
Construction	do.	79.6	80.6	85.2
Transportation and public utilities	do.	90.9	93.6	95.8
Wholesale and retail trade	do.	411.6	420.6	434.7
Finance, insurance, real estate	do.	95.7	99.6	105.2
Services	do.	356.6	375.1	393.0
Government and government enterprises	do.	334.5	342.8	349.3
Total <sup>2</sup>	do.	1,659.6	1,710.4	1,770.2
<b>Personal income:</b>				
Total	millions	\$58,341	\$62,269	\$66,978
Per capita	do.	\$13,411	\$14,128	\$15,009
<b>Hours and earnings:</b>				
Total average weekly hours, production workers	do.	38.8	39.0	39.4
Total average hourly earnings, production workers	do.	\$11.6	\$11.6	\$11.8
<b>Earnings by industry:<sup>3</sup></b>				
Farm income	millions	\$1,188	\$1,029	\$1,384
Nonfarm	do.	\$40,308	\$43,128	\$46,540
Mining total	do.	\$155	\$196	\$206
Metal mining	do.	\$12	\$13	\$19
Nonmetallic minerals except fuels	do.	\$40	\$38	\$36
Coal mining	do.	\$31	\$35	\$39
Oil and gas extraction	do.	\$72	\$110	\$113
Manufacturing total	do.	\$8,757	\$9,275	\$10,150
Primary metal industries	do.	\$511	\$474	\$452
Stone, clay, and glass products	do.	\$178	\$183	\$190
Chemicals and allied products	do.	\$380	\$425	\$442
Petroleum and coal products	do.	\$83	\$95	\$92
Construction	do.	\$2,348	\$2,839	\$3,115
Transportation and public utilities	do.	\$2,962	\$3,079	\$3,222
Wholesale and retail trade	do.	\$7,036	\$7,416	\$7,909
Finance, insurance, real estate	do.	\$2,230	\$2,540	\$2,952
Services	do.	\$7,913	\$8,702	\$9,491
Government and government enterprises	do.	\$7,966	\$8,574	\$8,894
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>4</sup>	do.	30,400	35,474	36,434
Value of nonresidential construction <sup>4</sup>	millions	\$1,217.4	\$1,309.3	\$1,437.0
Value of State road contract awards <sup>5</sup>	do.	\$212.0	\$417.0	\$371.4
Shipments of portland and masonry cement to and within the State	thousand short tons	1,163	1,214	1,258
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$202.7	\$221.6	\$376.6
Value per capita	do.	\$47	\$50	\$84

<sup>P</sup>Preliminary. <sup>T</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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



**Mineral Symbols**

- Ag Silver
- Al Aluminum plant
- Au Gold
- Cu Cement plant
- Clay Clay products
- Di Diatomite
- Dol Dolomite
- Gyp Gypsum plant
- Ls Limestone
- Ol Olivine
- Peat Peat
- Qtz Quartzite
- SG Sand and Gravel
- Si Silica
- St Stone
- Talc Talc
- Ti Titanium plant
- Zn Zinc

Figure 1.—Principal mineral-producing localities in Washington.

**Trends and Developments.**—The 1985 resurgence of lode gold mining as a major contributor to Washington's mineral economy continued into 1986. For more than 50 years, the State has had a steady, but relatively modest gold production, principally from one mine in the Republic District. In 1986, a major new gold mine went into production in the Wenatchee District.

Worldwide overproduction of aluminum and consequent depressed markets adversely affected the State's aluminum industry. The industry was severely affected by static, low production levels, by a nationwide strike against one major producer that closed two smelters in the State, and by the shutdown of two smelters by the operating companies during the last half of the year. A midyear lowering of electric power rates by the Bonneville Power Administration (BPA), the sale and planned reopening of one shutdown smelter, and a production increase by one company seemed to indicate that the industry's general position was improving at yearend.

**Employment.**—The startup of production at a major gold mine, accelerated development and production at another, and a modest upswing in the mineral construction materials industries contributed to a 7% increase in the State's mining employment. According to the State of Washington Employment Security Department, mining and quarry employment rose to about 2,900 people from the 2,700 total in 1985.

However, employment in the aluminum reduction and fabrication sectors of the State's metals industry slumped drastically to 6,600, compared with a total of 8,600 employed in those sectors in 1985.

**Exploration Activities.**—The level of exploration for metallic minerals in Washington was down from that of 1985. The number of companies exploring for gold deposits in the Wenatchee District, Chelan County, declined in 1986 from the record-high level achieved in 1984, as Asamera Minerals (U.S.) Inc. firmed up its land position around the Cannon Mine. Teck Resources (U.S.) 1983 Inc. conducted geological, geochemical, and geophysical exploration, and drilling on its property in the Wenatchee area. In the Blewett District of Chelan County, Tillicum Gold Mines Ltd. drilled six holes along a 2,400-foot strike length of the Peshastin vein, and J and S Mining explored a gold placer property on Peshastin Creek. Sunshine Valley Minerals Inc. continued work on gold-bearing tailings at the

Holden property, south of Lake Chelan.

A substantial part of the State's 1986 precious metal exploration activity was concentrated in and around the Republic and Danville Districts in northwestern Ferry County. In addition to exploration work by the operating mining companies, Newmont Exploration Ltd. drilled in the Danville District and carried out geological, geochemical, and geophysical exploration in the region, and NICOR Mineral Ventures explored for stockwork gold and silver deposits within volcanic rocks.

In Okanogan County, Keystone Gold Inc. continued geochemical and geophysical work on the Gray Eagle property and drilled at the Crystal Butte claims. Richard Dart conducted exploration at the Poland China Mine in the Meyers Creek District; Kerr-McGee Corp. did reconnaissance exploration in the Chesaw area; and Nord Resources Corp. drilled its gold property in Smith Canyon. Sundance Mining-Development Inc. evaluated the Ida Mine.

Columbia Ocean Minerals drilled an offshore bar near the mouth of the Columbia River, Pacific County. The project was designed to investigate potential concentrations of gold and accessory titanium and iron ore possibly transported from mineralized areas in the river's upper drainage.

Several companies explored for base and precious metals in Pend Oreille County. Pintlar Corp., owner of the Pend Oreille lead-zinc mine, which was permanently closed in 1986, conducted exploration elsewhere in the Metaline District, and La Sota-Jones Lead-Zinc Corp. drilled property near Metaline Falls. Lewis and Clark Mining Co. explored its claim group near Sullivan Lake, and Cominco American Incorporated explored for massive sulfide deposits containing lead, silver, and zinc in rocks assigned to the Precambrian Belt Supergroup.

Rochester Mining Co. drilled at the First Thought gold mine in Stevens County, and Billiton Exploration USA Inc. concluded geological and geophysical exploration on a lead-zinc deposit in the northern part of the county. Mines Management Inc. continued exploration at the Advance, Iroquois, and HC lead-zinc properties, and Leadpoint Consolidated Mines Co. worked on its property in the Northport District. Minexco Inc. explored polymetallic stratabound and vein deposits in the Huckleberry Mountains. Boise Cascade Corp. continued exploration for disseminated and massive sulfide deposits on corporate lands in Stevens County,



and NICOR Mineral explored for silver and base metal deposits in the Kootenai Arc.

The Seattle-St. Louis Mining Co. explored for gold at the Minnesota Mine, Whatcom County, and Stray Horse Resources Inc. conducted open pit and underground sampling at the New Light gold mine in the Slate Creek District. In Yakima County, Ardic Exploration and Development Ltd. explored at its Morse Creek bulk-tonnage gold target in Tertiary igneous rocks.

Coeur Exploration Inc., Lacana Gold Inc., Kennecott, Rio Algom Inc., Homestake Mining Co., and American Copper & Nickel Co. Inc. explored for precious metals on a statewide basis during the year.

FRM Minerals Inc. and partner United Catalyst Inc. geologically explored and drilled a talc property in Pend Oreille County; NICOR Mineral explored for talc in the same county. Meridian Minerals Co. reportedly drilled a high-calcium limestone property near Gardner Caves State Park, Pend Oreille County.

Meridian Minerals also continued a statewide exploration and development program for diatomite, limestone, pumice, sand and gravel, and stone. The work was conducted in Grant, King, Kittitas, Pend Oreille, Pierce, and Snohomish Counties.

**Legislation and Government Programs.**—A proposal to sell the Federal Government's BPA was abandoned after strong opposition by the Northwestern States' Governors and congressional delegations. The Northwest Power Planning Council calculated that the sale of BPA to private interests would raise wholesale power rates by 71.7%, thereby driving most of the Northwest's aluminum companies and other electricity-dependent industries out of business.

An unsuccessful 1985 proposal for a large-scale interagency land exchange between the U.S. Forest Service and the U.S. Bureau of Land Management (BLM) was revived in early 1986. The scaled-down plan called for the BLM to transfer 312,000 acres in Washington to the Forest Service; the 2.5 million acres of mineral trust responsibility on Indian tribal lands in Washington would have remained with BLM and would have been that agency's sole jurisdiction in the State. In addition, the plan called for a 24-position staff reduction in the BLM's Spokane office. The proposed exchange generally was opposed by the mining industry on the grounds that a change in Federal land management would destroy working

relationships built up over the years. The proposal awaited enabling legislation in 1986.

Legislation creating the 277,000-acre Columbia River Gorge National Scenic Area was signed into law in November. The law established joint State-U.S. Forest Service management of the 60-mile-long gorge, where the Columbia River cuts through the Cascade Mountains between Washington and Oregon. The law, which severely restricts commercial development in the gorge, prohibits new surface mining or hydroelectric projects in the scenic area.

Mineral leasing payments to Washington by the BLM totaled about \$301,000 in 1986.

Total revenue from prospecting, mining, and quarrying on State lands was \$451,906 for the fiscal year ending June 30, 1986. This figure, down about 30% from that realized in 1985, represented a drop in revenues from mineral leases and contracts and from sand and gravel production. In April, the Commissioner of Public Lands suspended the issuing of mining contracts and prospecting leases on State-managed lands awaiting new legislation to increase revenues. New applications for prospecting or mining on about 3.6 million acres of State-managed lands were put on hold until the 1987 legislature had a chance to act on the new mining laws. The commissioner's order affected about 180 prospecting leases and about 20 mineral contracts; most lands involved were in northwestern and northeastern Washington.

The State of Washington and the Colville Federated Tribes signed an agreement enabling the tribes to regulate all mining operations on the Colville Reservation. Under the agreement, mining on the reservation will be regulated under the Colville Mining Practices Water Quality Act, and the Colville Geology Department will enforce State Department of Natural Resources regulations for any mines on fee (private) lands within the reservation. Prior to the agreement, the tribes were responsible for primary enforcement on reservation lands held in trust by the Federal Government, and the State took direct responsibility for regulating any mining operations on private reservation lands.

The Washington Division of Geology and Earth Resources (DGER) continued work on the nearly completed southwestern quadrant for the new 1:250,000-scale, 4-part State geologic map. Fieldwork and geologic compilation were done on the northeastern

quadrant map. In addition, DGER published three information circulars, four open-file reports, and three newsletters during 1986.

The Mining and Mineral Resources Research Institute of the University of Wash-

ington, Seattle, received an allotment of \$142,000 from the U.S. Bureau of Mines in 1986. The institute has received a total of \$1.2 million since inception of the program in 1978.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Barite.**—Reflecting the depressed barite market caused by the continued slump in domestic oil and natural gas exploration and production drilling, Washington did not produce barite in 1986. No exploration for barite deposits was reported during the year, and Montana Barite Co. Inc. dropped its lease on the Bobcat barite deposit near Newport, Pend Oreille County.

**Calcium Chloride (Synthetic).**—Tahoma Chemical Co. Inc., in Steilacoom, Pierce County—a new concern that commenced operation in November 1985—and Occidental Chemical Corp., at Tacoma, Pierce County, manufactured synthetic calcium chloride using limestone and hydrochloric acid.

**Cement.**—The quantity and value of portland cement production in the State decreased moderately from the totals achieved in 1984 and 1985. Portland cement was produced by four companies in King, Pend Oreille, and Whatcom Counties: Ash Grove Cement West Inc. and Ideal Basic Industries Inc., Seattle; Lehigh Portland Cement Co., Metaline Falls; and Columbia Northwest Cement Corp., Bellingham. Ash Grove, Ideal Basic, and Lehigh Portland also produced masonry cement.

Portland cement was used by ready-mixed concrete companies (83%), concrete product manufacturers (6%), highway contractors (5%), miscellaneous customers (2%), and others, including building material dealers, other contractors, and government agencies (4%). Finished portland cement was shipped from plants to terminals by rail (63%), truck (19%), and barge (18%); shipment from plants and terminals to customers was by truck (71%), rail (28%), and by barge and other means (1%).

Individual cement plants used a mix of bituminous and anthracite coal, natural gas, and fuel oil for fuel; all four companies purchased electricity for energy. Raw materials consumed were anhydrite, cement rock, clay, fly ash, gypsum, iron ore, limestone, pyrite, quartz, sand, and slag.

**Clays.**—Clay production increased nearly 4% in quantity and more than 11% in value

from that reported for 1985. Clay was produced by 5 companies from 11 deposits in 6 counties. Nearly 81% of the State's clay production came from Clallam and King Counties; fire clay was produced from three pits in King and Stevens Counties. About 97% of the clay production was used for common brick or face brick, or in portland cement; the remainder was consumed in firebrick fabrication, flue linings, and structural tile.

**Diatomite.**—Washington's diatomite production increased 6% in quantity and nearly 7% in value over that reported for 1985. Witco Corp.'s Inorganic Specialties Div., the State's only diatomite producer, mined and processed diatomite at Quincy, Grant County.

**Gypsum.**—Crude gypsum production in the State tripled in quantity and doubled in value from that of 1985. Crude gypsum was mined by Agro Minerals Inc. from Washington's only gypsum operation near Tonasket, Okanogan County. Agro Minerals has mined gypsite from small saline lake bottoms since 1948; the dried and sized gypsum product was used as a soil conditioner. Calcined gypsum was produced by Norwest Gypsum Inc. in Seattle, and by Domtar Gypsum America Inc. at Tacoma, Pierce County.

**Lime.**—The State's lime production and value were slightly higher than in 1985. Quicklime was produced by Northwest Alloys Inc. near Addy, in Stevens County; Continental Lime Inc. produced quicklime and hydrated lime at its Tacoma plant.

**Olivine.**—Olivine production reported from the State decreased nearly 11% in quantity but increased by about 73% in value from that of 1985. Applied Industrial Material Corp. (AIMCOR) produced olivine from the Twin Sisters Mine in Skagit County. In November, AIMCOR purchased the mine from International Minerals and Chemical Corp., its former owner and operator.

Olivine Corp. mined and milled olivine from the Swen Larsen quarry, Whatcom County.

**Peat.**—Peat production was about the same level as that of 1985, although the value increased by 8%. Three companies—Ocean Farms Inc. in Grays Harbor County, Maple Valley Humus in King County, and Bonaparte Peat in Okanogan County—reported production of sold-in-bulk peat.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Washington's 1986 output of construction sand and gravel increased 13% in quantity

and 25% in value from that reported for 1984. The State ranked 10th in the Nation in the production of construction sand and gravel. Of 39 counties, 32 reported production, with Clark, King, Pierce, Snohomish, and Spokane accounting for nearly 66% of the total output. Major uses were for concrete aggregate (28%), road base and coverings (21%), fill (12%), asphaltic concrete aggregates (8%), and other (23%). About 43% of the State's construction sand and gravel was transported by truck, and 11% was moved by waterways; the remainder was transported by railroad or by other transportation means, or was processed into end-use products on-site.

**Table 4.—Washington: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	7,407	\$25,164	\$3.40
Plaster and gunitite sands -----	88	441	5.01
Concrete products (blocks, bricks, pipe, decorative, etc.)-----	256	948	3.70
Asphaltic concrete aggregates and other bituminous mixtures	2,107	7,123	3.38
Road base and coverings <sup>1</sup> -----	5,522	17,208	3.12
Fill -----	4,448	8,464	1.90
Snow and ice control -----	175	519	2.97
Railroad ballast -----	45	212	4.71
Other -----	254	1,184	4.66
Other unspecified <sup>2</sup> -----	6,040	15,124	2.50
Total or average -----	26,342	76,387	2.90

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

**Industrial.**—Industrial sand and gravel in the State decreased substantially in both production and value from that recorded for 1984. Production was reported by two operations in King and Stevens Counties; primary uses were for glass containers (53%), sandblasting (14%), cement manufacture (9%), fiberglass (9%), and flat glass manufacture (7%).

Wenatchee Silica Products, Chelan County, was purchased by Asamera; the bulk of the silica sand production was used in-house as the sand fraction for concrete backfill at Asamera's Cannon gold mine.

Industrial Mineral Products Inc. sold its Ravensdale silica sand operation and Chewelah magnesium recovery plant to L-Bar Products Inc. L-Bar Products continued to produce amber glass container sand at Ravensdale.

Lane Mountain Silica Co. produced flint glass sand at its Valley operation in Stevens County. The company updated its plant during the year; a new dryer and magnetic separators were added to accommodate increased production and purity requirements

associated with its contract to supply the new PPG Industries Inc. plate glass plant at Chehalis.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

**Crushed.**—The quantity of crushed stone production in Washington was estimated to have decreased nearly 6%, although the value was estimated to have increased by about 10%.

Columbia River Carbonates began production of ground white calcium carbonate at its plant in Woodland, Cowlitz County. Plant feed was a white marble quarried near Wauconda, Okanogan County; the quarry product was trucked to Tonasket and rail-shipped to the Woodland plant. The marble, grading 98% calcium carbonate, has a high brightness property, rendering it suitable for use in paint, paper products, and plastics.

Pacific Calcium Inc. produced dolomite

and limestone from two quarries in Okanogan County; the carbonate was crushed and marketed for poultry grit and agricultural uses.

Northwest Alloys quarried dolomite near Addy, Stevens County, for use in magnesium metal production. Nanome Aggregates Inc. produced dolomite for fillers, decorative stone, and terrazzo from several Stevens County quarries. Allied Minerals Inc., Chewelah Eagle Mining Co., and Northwest Marble Products Co. mined white dolomite, dolomitic limestone, and marble, respectively, from quarries in Stevens County.

**Sulfur (Recovered).**—The State's sulfur production, recovered as byproduct from petroleum refining, increased nearly 9% in quantity and 11% in value. Sulfur production was reported by Texaco Inc. from its Puget Sound refinery, Skagit County, and by Atlantic Richfield Co. and Mobil Oil Corp. from their Cherry Point and Ferndale refining operations in Whatcom County.

## METALS

**Aluminum.**—Although aluminum production in Washington decreased by 8% in quantity and value, the State retained its first ranking nationally and was credited with nearly 30% of the domestic aluminum output in 1986. The worldwide oversupply and resultant depressed aluminum prices carrying through from mid-1984 adversely affected Washington's aluminum industry, to the extent that it operated at only about 80% of rated capacity. An additional local adverse factor was escalated electric power rates, which had increased 800% over the previous 5 years. In midyear, the BPA announced availability of a variable power rate that linked the smelter's power costs to the price of aluminum. The Federal Energy Regulatory Commission gave interim approval to the variable rate and allowed the rate to take effect on August 1. All 10 of the Pacific Northwest's aluminum smelters, including 2 that were shut down, signed up for BPA's variable rate.

A June 1 strike over new union contracts that would have reduced workers' benefits affected production at Aluminum Co. of America (Alcoa) smelters at Vancouver and Wenatchee. The company immediately announced permanent closure of the Vancouver plant, putting 600 people out of work. Supervisory personnel kept the Wenatchee plant going at a reduced scale until early August, when the strike was settled and full-scale production resumed.

Vanalco Inc., a subsidiary of Bay Resources Corp., agreed in late October to purchase the idled Vancouver smelter; a restart of operations was projected for the first quarter of 1987.

On July 31, union workers at Commonwealth Aluminum Corp.'s Goldendale smelter were locked out, following failure to agree on a new labor contract. The plant was operated at a reduced rate by supervisory personnel until October, when the union employees accepted a reduced wage and benefit package and returned to work. In late November, Commonwealth announced that the smelter would close permanently by yearend. A personal appeal by Washington's Governor delayed the planned closure until mid-January 1987; the delay was designed to allow the company to evaluate offers by prospective purchasers. A permanent closure of the smelter would have meant lost jobs for about 600 workers.

Table 5.—Washington: Estimated primary aluminum plant production data

Year	Quantity (thousand metric tons)	Percent of national total	Value (thousands)
1983 -----	981	29	\$1,682,233
1984 -----	1,126	27	2,010,971
1985 -----	979	28	1,747,502
1986 -----	902	30	1,611,140

**Arsenic.**—ASARCO Incorporated shipped byproduct arsenic trioxide and arsenic metal from stock at its terminated Tacoma copper smelter. The smelter, which had been the only domestic processor of high-arsenic copper concentrates, closed permanently in March 1985.

**Gold and Silver.**—Washington's gold production, reported from four lode mines in Chelan and Ferry Counties, more than doubled in quantity and nearly tripled in value from that achieved in 1985; the State ranked fifth in the Nation for gold production. Silver, as a byproduct from gold recovery, was reported from three lode mines; the production almost doubled in quantity and increased 90% in value from that of 1985.

Asamera-Breakwater Resources Ltd.'s Cannon Mine at Wenatchee, Chelan County, ranked 1st in gold production in the State and gained the 10th rank nationally. Full-scale commercial production commenced at the Cannon on January 1, and design-capacity mechanized cut-and-fill stoping began in March. According to Asamera's annual report, the 1,500-short-ton-

per-day-capacity mine produced a total of 116,514 troy ounces of gold and 178,202 troy ounces of silver from 448,160 tons of ore during the year. A 50-day midyear shutdown to repair a cracked ball mill trunnion bearing reduced the tonnage throughput considerably. The mill was modified by the addition of a flash unit and column cells to the flotation circuit, resulting in improved gold recovery rates that averaged more than 86% in 1986. Concentrates produced by the Cannon Mine were shipped by rail to Vancouver, WA, where they were loaded for sea transport to smelters in the Federal Republic of Germany and Japan. The completion of 53,000 feet of detailed underground drilling during the year resulted in the discovery of a new ore body, termed the B-4 zone. Delineation of the zone added 544,000 tons of ore grading 0.239 troy ounce per ton of gold to the mine's ore reserves. At yearend, the Cannon Mine had recorded 3,727,000 tons of proven and probable ore reserves at an average grade of 0.306 troy ounce of gold per ton.

Exploration drilling on properties sited 2 miles southeast of the Cannon Mine further delineated several mineralized zones discovered in 1985. A total of 7,820 feet of exploration drilling in the old Lovitt Mine (D Reef) area was completed in 1986; encouraging results initiated a further planned program for 1987.

Hecla Mining Co.'s Republic Unit (Knob Hill) Mine at Republic, Ferry County, was Washington's second-ranked gold producer in 1986. Hecla's annual report credits an output of 39,866 troy ounces of gold and 134,412 troy ounces of silver from 58,681 tons of ore during the year. The new 1,300-foot-deep, \$2.2 million Golden Promise Shaft and hoisting facility were completed in November. The 6-foot-diameter, steel-lined drilled shaft accesses the newly discovered Golden Promise ore body, where the Golden Promise No. 1 and No. 2 veins were being developed on three levels. The new shaft, which connects with the 1100 level of the old Knob Hill Mine, was used primarily to transport equipment and personnel; ore was trammed nearly 1 mile to the Knob Hill No. 2 shaft for hoisting. Exploration and development work at the Republic Unit has delineated proven and probable ore reserves totaling about 372,000 tons, averaging 1.0 troy ounce of gold and 4.5 troy ounces of silver per ton. Drilling has indicated an additional 756,000 tons of mineralized material grading 0.39 troy

ounce of gold per ton and 1.7 troy ounces of silver per ton; additional drilling and drifting to further explore the Golden Promise Zone was undertaken in 1986. The newly discovered reserves were deemed sufficient to ensure up to 10 years of further operation; prior to discovery of the new veins, closure of the mine had been anticipated by mid-1986.

High Country Mining and Engineering commenced production at the Gold Valley Mine, Ferry County, and Vulcan Mountain Inc. continued leaching operations at the Gold Dike Mine near Danville, Ferry County.

Echo Bay Exploration Inc., under a joint venture with Crown Resources Corp. and Gold Texas Resources Ltd., explored at the Granny and Key gold properties, Ferry County. According to the Echo Bay quarterly report, drilling at the Key property identified geological reserves of about 1 million tons with an undiluted grade of approximately 0.15 troy ounce of gold per ton.

J and S Mining operated the China Gap gold placer mine on high bench areas of the Sultan River, Snohomish County.

CSS Management Corp. continued development at the Apex, Cleopatra, and Damon properties in King County and made improvements to its pressure-leaching mill in Skykomish.

**Magnesium.**—Magnesium metal production in Washington was reported by the U.S. Bureau of Mines for the first time in 1986; the magnesium production value was a very significant addition to the total nonfuel mineral production value for the State. Washington ranked second in the Nation in magnesium metal production for the year. Northwest Alloys, a wholly owned subsidiary of Alcoa, operated its magnesium metal plant at Addy, Stevens County, at near capacity during the year. Through technological improvements, Northwest Alloys raised output at Addy to about 4,000 short tons per year for each of its nine furnaces, or to approximately 36,000 tons per year from an original design capacity of about 25,000 tons per year overall. Most of Northwest Alloys' production was used by parent company Alcoa as an alloying ingredient in aluminum manufacture; however, Northwest Alloys also sold magnesium metal to selective customers in the Japanese and European metal markets. The Addy plant produced magnesium metal from locally mined magnesium dolomite, employing a silicothermic process using purchased ferrosilicon and in-plant-manufactured

aluminum-quartzite flux; the two other domestic operations recovered magnesium metal from the electrolytic treatment of brines.

Northwest Alloys sold its process waste sludge to L-Bar Products, which recovered magnesium salts and metal at a plant in Chewelah, Stevens County.

**Silicon.**—Union Carbide Corp. operated an expanded polycrystalline silicon plant at Moses Lake, Grant County. Technological improvements carried out during the year resulted in increased production capacity and a reduction in the amount of electrical energy consumed. Union Carbide, which employed 252 people at the Moses Lake operation, was the largest single employer and the largest volume user of electricity in the Moses Lake area.

M. A. Hanna Co. continued production of silicon and ferrosilicon at the Rock Island smelter, Douglas County. Ferrosilicon production decreased during the year, largely because of reduced demand from the northwestern aluminum industry. Chemical-

grade silicon metal was sold to Union Carbide for use at its Moses Lake facility.

**Steel.**—Northwest Steel Rolling Mills, a Seattle-based company manufacturing concrete reinforcing bars and other steel construction materials, was sold late in the year to Birmingham Steel Corp. of Alabama. Northwest Steel employed 390 workers and had about \$40 million in annual sales to consumers in Alaska, British Columbia, Hawaii, and on the west coast.

**Titanium.**—A slow market for titanium metal in 1986 led to the yearend announcement of closure of International Titanium Inc.'s (ITI) Moses Lake titanium sponge plant, Grant County. The closure, part of a corporate cost-cutting plan by parent company Wyman Gordon Co. was to take place over an 8-week period, putting 160 people out of work. Earlier in the year, ITI decreased production and laid off 15% of the plant work force.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Spokane, WA.

<sup>2</sup>Geologist, Washington Division of Geology and Earth Resources, Spokane, WA.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
<b>Aluminum:</b>			
Aluminum Co. of America -----	Box 221 Wenatchee, WA 98801	Plant -----	Chelan.
Commonwealth Aluminum Corp., a subsidiary of Comalco Pty. Ltd. -----	95 Collins St. Melbourne, Victoria 3000 Australia	----do -----	Klickitat.
Intalco Aluminum Corp. -----	Box 937 Ferndale, WA 98248	----do -----	Whatcom.
Kaiser Aluminum & Chemical Corp. -----	Box 6217 Spokane, WA 99207	----do -----	Spokane.
Do -----	3400 Taylor Way Tacoma, WA 98421	----do -----	Pierce.
Reynolds Metals Co. -----	Box 999 Longview, WA 98632	----do -----	Cowlitz.
<b>Cement:</b>			
Ash Grove Cement West Inc. ---	5550 SW. Macadam Ave. Suite 300 Portland, OR 97201	----do -----	King.
Columbia Northwest Cement Corp. <sup>1</sup> -----	Box 37, Marietta Rd. Bellingham, WA 98227	----do -----	Whatcom.
Ideal Basic Industries Inc. -----	Box 8789 Denver, CO 80201	----do -----	King.
Lehigh Portland Cement Co. ---	718 Hamilton Mall Box 1882 Allentown, PA 18105	----do -----	Pend Oreille.
<b>Clays:</b>			
Ideal Basic Industries Inc. -----	Box 8789 Denver, CO 80201	Pit -----	Clallam.
Mutual Material Co. -----	Box 2009 Bellevue, WA 98009	Pits and plant. ---	King and Pierce.
<b>Diatomite:</b>			
Inorganic Specialties, a division of Witco Corp. -----	520 Madison Ave. New York, NY 10072	Mine and plant. --	Grant.
<b>Gold:</b>			
Asamera Minerals (U.S.) Inc. ---	2100, 144 4th Ave. SW. Calgary, AB T2P 3N4 Canada	Underground mine and mill.	Chelan.
Hecla Mining Co. <sup>2</sup> -----	6500 Mineral Dr. Box C-8000 Coeur d'Alene, ID 83814-1931	----do -----	Ferry.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Lime:</b>			
Continental Lime Inc -----	1220 Alexander Ave. Tacoma, WA 98421	Plant -----	Pierce.
Northwest Alloys Inc -----	Box 115 Addy, WA 99101	Mine and plant --	Stevens.
<b>Magnesium:</b>			
Northwest Alloys Inc. <sup>3</sup> -----	Box 138A, Route 1 Addy, WA 99101	-----do -----	Do.
<b>Olivine:</b>			
Applied Industrial Material Corp	Box 58 Hamilton, WA 98225	-----do -----	Skagit.
<b>Peat:</b>			
Maple Valley Humus -----	18905 SE, 170th St. Renton, WA 98055	Bog -----	King.
Ocean Farms Inc -----	Ocean City, WA 98569 -----	Bog -----	Grays Harbor.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Associated Sand & Gravel Co. Inc.	Box 2037 Everett, WA 98203	Pits -----	Skagit and Snohomish.
Central Pre-Mix Concrete Co	Box 3366 Spokane, WA 99220	-----do -----	Various.
Friday Harbor Sand & Gravel Co.	580 Pear Point Rd. Friday Harbor, WA 98250	-----do -----	San Juan.
Lakeside Sand & Gravel Co. Inc.	Box 46 Issaquah, WA 98207	-----do -----	King.
Miles Sand & Gravel Co ----	Box 130 Auburn, WA 98002	-----do -----	King and Kitsap.
Northwest Aggregates Co --	63020 Grandview Dr. West Tacoma, WA 98467	Pit -----	Pierce.
Stoneway Concrete Inc -----	1915 Maple Valley Hwy. Renton, WA 98055	Pits -----	King.
<b>Industrial:</b>			
Lane Mountain Silica Co.---	Box 236 Valley, WA 99181	Quarry and plant	Stevens.
L-Bar Products Inc -----	Box 95 Ravensdale, WA 98051	-----do -----	King.
<b>Stone:</b>			
Columbia River Carbonates ----	Box D Woodland, WA 98674	-----do -----	Cowlitz and Okanogan.
Pacific Calcium Inc. -----	186 Holmes Rd. Tonasket, WA 98855	Quarries -----	Okanogan.
<b>Sulfur (recovered):</b>			
Atlantic Richfield Co. -----	4519 Grandview Rd. Ferndale, WA 98248	Plant -----	Whatcom.
Mobil Oil Corp -----	3901 Unick Rd. Ferndale, WA 98248	-----do -----	Do.
Texaco Inc -----	600 Texas Rd. Anacortes, WA 98221	-----do -----	Skagit.
<b>Titanium:</b>			
International Titanium Inc ----	1320 Wheeler Rd. Moses Lake, WA 98837	Sponge metal plant.	Grant.

<sup>1</sup> Also stone.<sup>2</sup> Also silver.<sup>3</sup> Also industrial sand and stone.

# The Mineral Industry of West Virginia

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

By L. J. Prosser, Jr.,<sup>1</sup> and Dewey S. Kirstein<sup>2</sup>

The value of West Virginia's nonfuel minerals production in 1986 was about \$130 million. The nonfuel minerals sector continued to be overshadowed by the State's coal mining industry. Of the approximately 1,100 mineral producers and processors in West Virginia, about 800 produced coal, 200

manufactured or processed mineral commodities, and 100 mined nonfuel minerals.

Crushed stone accounted for about one-third of the State's total nonfuel minerals value. Steel was the dominant commodity in West Virginia's primary metal industries.

Table 1.—Nonfuel mineral production in West Virginia<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons ..	381	\$3,410	331	\$3,342	215	\$470
Gem stones ..	—	W	—	W	NA	1
Salt ----- thousand short tons ..	1,004	W	895	W	W	W
Sand and gravel (construction) ----- do. ....	976	3,198	<sup>e</sup> 900	<sup>e</sup> 3,000	1,501	5,365
Stone (crushed) ----- do. ....	<sup>e</sup> 9,100	<sup>e</sup> 37,300	9,393	38,348	<sup>e</sup> 9,800	<sup>e</sup> 37,500
Combined value of cement, lime (1984-85), sand and gravel (industrial), and values indicated by symbol W -----	XX	68,279	XX	60,719	XX	86,473
Total -----	XX	112,187	XX	105,409	XX	129,809

<sup>e</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



Table 2.—Nonfuel minerals produced in West Virginia in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Berkeley	Cement, stone (crushed), clays.
Grant	Stone (crushed).
Greenbrier	Do.
Hampshire	Do.
Hancock	Clays.
Harrison	Stone (crushed).
Jefferson	Do.
Kanawha	Do.
Logan	Do.
Marshall	Salt, stone (crushed).
Mercer	Stone (crushed).
Mineral	Do.
Monongalia	Do.
Morgan	Sand (industrial).
Pendleton	Stone (crushed), lime.
Pocahontas	Stone (crushed).
Preston	Do.
Raleigh	Do.
Randolph	Do.
Tucker	Do.
Tyler	Salt.
Wyoming	Stone (crushed), sand (industrial).
Undistributed <sup>2</sup>	Sand and gravel (construction).

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of West Virginia business activity

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>
<b>Employment and labor force, annual average:</b>			
Population	-----	-----	-----
Total civilian labor force	-----	-----	-----
Unemployment	-----	-----	-----
	-----	-----	-----
<b>Employment (nonagricultural):</b>			
Mining total <sup>1</sup>	-----	-----	-----
Nonmetallic minerals except fuels <sup>2</sup>	-----	-----	-----
Coal mining	-----	-----	-----
Oil and gas extraction	-----	-----	-----
Manufacturing total	-----	-----	-----
Primary metal industries	-----	-----	-----
Stone, clay, and glass products	-----	-----	-----
Chemicals and allied products	-----	-----	-----
Petroleum and coal products <sup>2</sup>	-----	-----	-----
Construction	-----	-----	-----
Transportation and public utilities	-----	-----	-----
Wholesale and retail trade	-----	-----	-----
Finance, insurance, real estate	-----	-----	-----
Services	-----	-----	-----
Government and government enterprises	-----	-----	-----
Total	-----	-----	-----
Personal income: <sup>4</sup>	-----	-----	-----
Total	-----	-----	-----
Per capita	-----	-----	-----
Hours and earnings:	-----	-----	-----
Total average weekly hours, production workers	-----	-----	-----
Mining (bituminous coal)	-----	-----	-----
Total average hourly earnings, production workers	-----	-----	-----
Mining (bituminous coal)	-----	-----	-----
Earnings by industry: <sup>4</sup>	-----	-----	-----
Farm income	-----	-----	-----
Nonfarm	-----	-----	-----
Mining total	-----	-----	-----
Nonmetallic minerals except fuels	-----	-----	-----
Coal mining	-----	-----	-----
Oil and gas extraction	-----	-----	-----
Manufacturing total	-----	-----	-----
Primary metal industries	-----	-----	-----
Stone, clay, and glass products	-----	-----	-----
Chemicals and allied products	-----	-----	-----
Petroleum and coal products	-----	-----	-----
Construction	-----	-----	-----
Transportation and public utilities	-----	-----	-----

See footnotes at end of table.

Table 3.—Indicators of West Virginia business activity —Continued

	1984 <sup>r</sup>	1985	1986 <sup>p</sup>	
<b>Earnings by industry<sup>4</sup> —Continued</b>				
Wholesale and retail trade	millions	\$1,888	\$1,961	\$2,020
Finance, insurance, real estate	do.	\$440	\$461	\$514
Services	do.	\$2,153	\$2,342	\$2,502
Government and government enterprises	do.	\$2,107	\$2,269	\$2,369
<b>Construction activity:</b>				
Number of private and public residential units authorized <sup>5</sup>		2,139	1,477	1,918
Value of nonresidential construction <sup>6</sup>	millions	\$136.7	\$141.9	\$151.0
Value of State road contract awards <sup>6</sup>	do.	\$290.0	\$280.0	\$238.0
Shipments of portland and masonry cement to and within the State				
	thousand short tons	474	416	454
<b>Nonfuel mineral production value:</b>				
Total crude mineral value	millions	\$112.2	\$105.4	\$129.8
Value per capita		\$58	\$64	\$68

<sup>p</sup>Preliminary. <sup>r</sup>Revised.

<sup>1</sup>Bureau of Labor Statistics, U.S. Department of Labor; totals may not add because of inclusion of data from other sources.

<sup>2</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>3</sup>Data do not add to total shown because of independent rounding.

<sup>4</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment owing to the inclusion of proprietors' income.

<sup>5</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>6</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

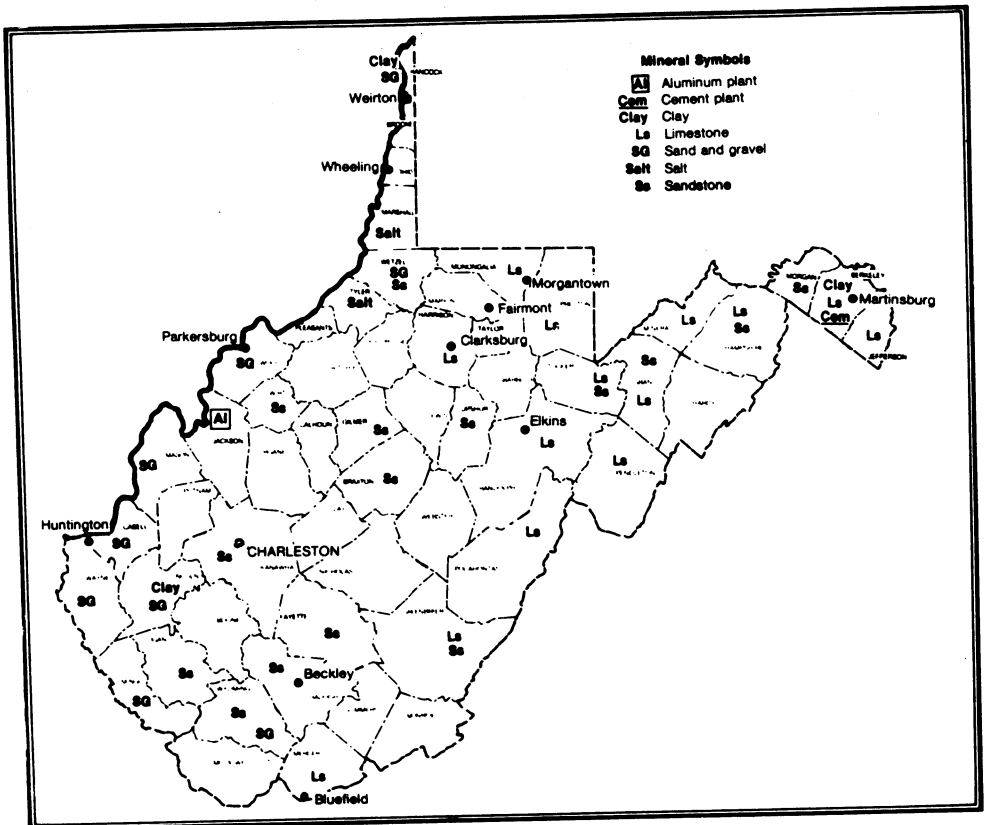


Figure 1.—Principal mineral-producing localities in West Virginia.

**Trends and Developments.**—Employment in mining and minerals manufacturing in West Virginia continued to decline in 1986. Total nonagricultural employment in the State, however, remained essentially unchanged since 1976 at about 597,000 persons. In the past decade, employment dropped 47% in the stone, clay, and glass industries; 46% in coal mining; 45% in primary metals; and 24% in chemicals and allied products. Despite these employment losses, production of stone and clay remained about the same, and coal production increased by about 22 million short tons since 1976. These figures indicate an increase in productivity and efficiency and imply that, unless a new demand source develops, employment levels of the 1970's will not be reached in these industries again.

In an attempt to create new demand for West Virginia's coal and limestone resources, a proposal to construct four 300-megawatt coal-fired powerplants was initiated by the State late in the year. Preliminary design parameters showed annual requirements for each plant of 800,000 short tons of coal and up to 125,000 tons of limestone. Electricity generated at the plants was expected to be sold to out-of-State customers.

**Legislation and Government Programs.**—Development of the State's mineral resources was often hampered by the lack

of clear property titles or unknown ownership of mineral rights. With the intent to facilitate development of coal, oil, gas, and other minerals, the West Virginia Legislature enacted House bill 1529 (chapter 55 of the Code of West Virginia, article 12-A). This legislation allowed a surface landowner or partial owner of mineral rights to petition the circuit court to authorize a lease for the mineral development sought. The legislature also enacted a bill granting a tax break to electric power companies that use coal mined in the State to generate electricity (chapter 11 of the Code of West Virginia, section 2-D, article 13).

Additional legislation relating to the coal industry was published in "Acts of the Legislature of West Virginia, 1986," chapters 107-109.<sup>3</sup>

The West Virginia Geological and Economic Survey was the State's principal agency involved in nonfuel mining activity. During the year, a catalog of publications, maps, and services was published.<sup>4</sup>

The Bureau of Mines conducted research projects in West Virginia on acid mine drainage, controlled burnout of coal waste banks, coal mine bumps, and subsidence prediction techniques. These projects were aimed at improving the environment and lowering mining costs. Results of these and other Bureau activities were summarized in "Bureau of Mines Research 86."<sup>5</sup>

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Capitol Cement Corp. operated the State's only cement plant in Martinsburg in Berkeley County. Strong demand from the construction industry, coupled with a \$5 million modernization program initiated in 1985, resulted in full capacity production in 1986. Masonry cement was also manufactured at the wet-process plant. Capitol Cement also quarried limestone and shale for internal consumption in the cementmaking process.

**Clays.**—Continental Brick Co. near Martinsburg mined common clay and shale for brick manufacture. Last year, Continental began burning coal for kiln fuel, which, in addition to lowering production costs, resulted in improved brick quality and color. The firm's primary market area, Washington, DC, is about 75 miles from the brick plant. Continental operated West Virginia's

only brick plant, which has an annual capacity of about 60 to 65 million brick. The State's other producers, Capitol Cement and Sanders Dummy Co., mined clays used for cement manufacturing and stemming explosives in coal mines, respectively.

Fire clay production by Globe Refractories Inc., Hancock County, ceased in 1985. In 1986, the firm sold its abandoned brickyard and barge docking facilities near Newell to local trucking firms.

**Gem Stones.**—Coral, opal, varieties of quartz, and cannel and bone coal were among the mineral specimens collected by hobbyists and rockhounds in West Virginia.

**Lime.**—Germany Valley Limestone Co., 5 miles northeast of Riverton, Pendleton County, was the State's only lime producer. The lime was sold for acid mine water neutralization, paper pulp processing, water purification, and sewage treatment.

**Salt.**—Output of salt declined for the

third consecutive year because of a closing and a strike. FMC Corp. ceased salt brine operations at Bens Run, Tyler County, in 1985. The firm was unsuccessful in its attempt to sell its chlorine-caustic soda plant in South Charleston and closed that facility. FMC continued manufacturing hydrogen peroxide at Spring Hill for use in treatment of contaminated ground water and wastewater.

The 600 union employees at PPG Industries Inc., the State's leading salt producer, were on strike from September through yearend. Salaried and managerial employees continued production at the Natrium plant, Marshall County, but at reduced levels. The salt was used to manufacture chlorine and caustic soda and was marketed to the plastic, pulp and paper, metal fabricating, petroleum refining, and rubber reclaiming industries.

LCP Chemicals-West Virginia Inc. produced salt brine and manufactured chlorine

and caustic soda at facilities in Moundsville, Marshall County. The firm, in operation since 1980, employed about 250 workers.

**Sand and Gravel.—Construction.**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

In 1986, five companies reported production of 1.5 million short tons of construction sand and gravel. Most of the State's output was dredged from the Ohio River. Crushed sandstone, quarried east of Elkins, was also marketed as construction sand and gravel because of a lack of that resource in the eastern part of the State. The Public Land Corp., a division of the Department of Natural Resources, received a 5-cent royalty for each ton of construction sand and gravel dredged in State-owned waters.

Table 4.—West Virginia: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	576	\$2,328	\$4.04
Asphaltic concrete aggregates and other bituminous mixtures -----	15	45	3.00
Fill -----	40	100	2.50
Snow and ice control -----	2	4	2.00
Other <sup>1</sup> -----	868	2,889	3.33
Total or average -----	1,501	*5,365	3.57

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>2</sup>Data do not add to total shown because of independent rounding.

**Industrial.**—The market for glass sand continued to shrink as the popularity and production of plastic containers increased. Glass recycling has also reduced demand for industrial sand. In West Virginia, U.S. Silica Co., a subsidiary of United States Borax & Chemical Corp. and The Rio Tinto Zinc Corp. PLC of the United Kingdom, continued to produce industrial sand used for glass manufacture at its plant and quarry in Morgan County. The firm's instate market declined further with the closing of two glass bottle manufacturing plants in Vienna.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Demand from the construction industry and markets in adjacent States boosted West Virginia's crushed stone production to 9.8 million short tons, the highest total since 1980. Output, particularly from the eastern border counties, was sold in Baltimore, MD; Washington, DC; and Virginia because of increased construction in those areas. Riverton Corp. operated a portable plant at a former J&L Steel Co. quarry east of Martinsburg, crushing waste rock for aggregate. About 90% of West Virginia crushed stone production is limestone; the remainder is sandstone.

Also during the year, Kenton Meadows Co. purchased and reopened Hawthorne Industries Inc.'s quarry in Randolph County. The 139-acre site northeast of Webster Springs has an estimated 55 million short tons of reserves. Kenton Meadows used the

limestone in its asphalt pavement business. During the year, Germany Valley received approval from the State to expand its quarry operations by 242 acres.

*Dimension.*—Fara Natural Stone Co. Inc. in Greenbrier County and Mazzella Quarries Inc. in Kanawha County produced dimension stone during 1986.

### METALS

Metals discussed in this section were processed from materials received from both foreign and domestic sources. No metals were mined in West Virginia. Production and value data for these metals, which are not included in table 1, are given, if available.

**Aluminum.**—Kaiser Aluminum & Chemical Corp., the State's only aluminum producer, temporarily idled one-half of the 163,000-short-ton-per-year Ravenswood plant during the year. The plant's annual rated capacity was about 4% of the total U.S. capacity. The plant was important to both the local and State economy, providing about 15% of the employment in West Virginia's primary metals sector.

**Iron and Steel.**—Although West Virginia produced less than 5% of the Nation's steel, primary and fabricated metals accounted for about 25% of the State's total employment in manufacturing. Weirton Steel Corp. and Wheeling-Pittsburgh Steel Corp. (W-P), which are both integrated producers, and Steel of West Virginia Inc., a minimill, accounted for the State's production.

The financial positions and futures of the integrated producers were in sharp contrast—Weirton reported a profit for the third consecutive year while W-P remained in chapter 11 bankruptcy proceedings for a second year.

In 1986, Weirton shipped 2.4 million short tons of steel for sales of \$1.2 billion, resulting in an income of \$45.1 million.<sup>6</sup> Steel, including hot-rolled, cold-rolled, hot-dipped galvanized, electrolytic zinc-plated, and Galfan<sup>TM</sup>-coated sheet products, accounted for most of the shipments. The firm employed about 8,400 workers in 1986.

The U.S. Department of Energy (DOE) accepted Weirton's request for funding to demonstrate the commercial viability of a coke-free ironmaking facility. Using the Kohle-Reduktion technology developed by Korf Engineering GmbH, the 330,000-ton-per-year plant proposed for Weirton would be a scaled-up version of a West German pilot plant. Weirton's application was for \$57.8 million in "Clean Coal Technology" funds. The proposed plant would use coal directly instead of coke in the production of

blast furnace quality iron. Contract negotiations continued with the DOE and Korf Engineering at yearend. Required financial arrangements must be developed that may include participation in the project by other domestic steel companies. Final project approval must also be given by Weirton's board of directors.<sup>7</sup>

The future of steelmaking by W-P, with debts in excess of \$1 billion, was expected to be decided in Federal bankruptcy court in 1987. The Nation's seventh largest steel producer, W-P, employed about 8,200 workers at plants in Ohio, Pennsylvania, and West Virginia. The firm filed for protection from creditors under Federal bankruptcy laws in April 1985 with liabilities, other than pensions, of more than \$500 million. The deadline for reorganization of the company and a schedule for debt payment were extended until February of 1987. Responsibility for W-P pension plan debts of \$665 million covering 21,600 retirees was shifted to the Federal Pension Benefit Guaranty Corp. (PBGC) as part of a negotiated labor agreement with the United Steelworkers of America. The PBGC subsequently filed a petition with the bankruptcy court requesting priority status—that is, to be paid before most other creditors.

Two other actions in 1986 involved W-P operations in West Virginia. At Follansbee, Wheeling Nisshin Inc. received a \$65 million industrial revenue bond for construction of a steel coating mill. The plant is scheduled to begin production in January of 1988 with an annual capacity of 250,000 short tons. Originally, W-P was an equal partner with Nisshin Steel Co. Ltd. of Japan, but because of the bankruptcy proceedings, the joint venture was restructured with W-P having a one-third interest. As part of the deal, W-P was expected to supply 75% of the steel coated at the Follansbee mill.

At Benwood, former employees of W-P's idled mill sought a partner to buy and reopen the plant under an employee stock ownership plan. During the year, two foreign companies toured the facility. The Benwood facility manufactured tubular products for the oil industry before a lack of sales forced closure in 1983. At yearend, the search continued. A buyout would be contingent on approval by the bankruptcy court.

Steel of West Virginia, Huntington, operator of the State's only minimill, accepted an estimated \$40 million offer by Charterhouse Group International Inc. of New York, which restructured ownership giving Charterhouse 70% interest. Steel of West

Virginia, the former Conners Steel Div. of H. K. Porter Co., has an annual capacity of 250,000 tons and employs 525 workers.

**Ferroalloys.**—Decline in demand from the domestic steel industry, combined with a marked increase in imports, resulted in a series of closures and cutbacks in the ferroalloy industry since the beginning of the decade. At yearend, only one company continued ferroalloy production in the State. In 1986, ferroalloy shipments dropped to about 54,000 short tons compared with 110,000 tons in 1985. In 1976, nearly 170,000 tons of ferroalloys was produced in West Virginia.

Chemetals Corp., a producer of ferromanganese and manganese powder products, permanently closed its Kingwood plant in November because of flood damage. Production of some of these ferroalloys was shifted to the company's expanded facilities in Baltimore, MD.

At yearend 1985, Foote Mineral Co. permanently closed its Graham plant. In 1986, Foote sold its specialty foundry product lines, including proprietary technology, trade names, and patents to SKW Alloys

Inc. in New York.

Elkem Metals Co., the State's only remaining ferroalloy producer, began a \$10 million modernization of power generating facilities at its Alloy silicon metal plant.

**Other Metals.**—Inco Alloys International Inc. continued to produce wrought high-nickel alloys at its Huntington plant in Cabell County. The Meadowbrook Corp., a wholly owned subsidiary of T. L. Diamond & Co. Inc., operated a zinc plant at Spelter, Harrison County. Corhart Refractories Co. produced high-density zircon and chromic oxide refractory brick using imported ores at its Buckhannon plant in Upshur County.

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<sup>2</sup>Economic geologist and head, Economic Section, West Virginia Geological and Economic Survey, Morgantown, WV.

<sup>3</sup>Acts of the Legislature of West Virginia, Regular Session, 1986, First Extraordinary Session 1986, State of West Virginia, West Virginia Legislature, State Capital Building, Charleston, WV, 1,648 pp.

<sup>4</sup>West Virginia Geological and Economic Survey. Publications, Maps, and Services, ED-A, 58 pp.

<sup>5</sup>U.S. Bureau of Mines. Bureau of Mines Research 1986. 131 pp.

<sup>6</sup>Weirton Steel Corp. 1986 Annual Report. P. 3.

<sup>7</sup>Pages 7-8 of work cited in footnote 6.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement: Capitol Cement Corp. <sup>1</sup> -----	Box 885 Martinsburg, WV 25401	Quarry and plant ---	Berkeley.
Clays: Continental Brick Co -----	Route 5, Box A-1 Martinsburg, WV 25401	Pit and plant -----	Do.
Sanders Dummy Co -----	Box 146 Midkiff, WV 25504	Pit -----	Lincoln.
Lime: Germany Valley Limestone Co -	Box 302 Riverton, WV 26814	Quarry and plant ---	Pendleton.
Salt: LCP Chemicals-West Virginia Inc. -----	Drawer J Moundsville, WV 26041	Brine wells and plant	Marshall.
PPG Industries Inc -----	1 Gateway Center Pittsburgh, PA 15222	---do -----	Do.
Sand and gravel: Construction: Dravo Corp -----	1 Oliver Plaza Pittsburgh, PA 15222	Dredges -----	Various.
ET&S Inc -----	Route 1 Cheshire, OH 45620	Quarry and plant ---	Mason.
Mason County Sand & Gravel Inc. -----	Route 2, Box 176-A Letar, WV 26253	---do -----	Do.
Standard Slag Co -----	1200 Stambaugh Bldg. Youngstown, OH 44501	Plant -----	Hancock.
Industrial: Tolers Sand Co -----	Route 1, Box 132B Welch, WV 24801	Dredge -----	Wyoming.
U.S. Silica Co. (a subsidiary of United States Borax & Chemical Corp.). -----	Box 187 Berkeley Springs, WV 25411	Quarry and plant ---	Morgan.
Stone: J. F. Allen Co. -----	Box 49 Clarksburg, WV 26301	Quarry -----	Randolph.
Fairfax Sand & Crushed Stone Co. -----	Box 98 Thomas, WV 26292	Quarries -----	Grant, Mineral, Randolph, Tucker.
Greer Limestone Co., a division of Greer Steel Co. -----	Greer Bldg. Morgantown, WV 26505	Mine and quarries --	Monongalia and Pendleton.
USX Corp -----	6 Grant St. Pittsburgh, PA 15230	Quarry -----	Jefferson.

<sup>1</sup>Also clays and crushed stone.



# The Mineral Industry of Wisconsin

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

By James J. Hill,<sup>1</sup> Thomas J. Evans,<sup>2</sup> and Wanda J. West<sup>3</sup>

Nonfuel mineral production in Wisconsin was valued at \$164.5 million in 1986, the highest value reported since the record-high year of 1979 and 32% over the \$125.1 million value reported in 1985. Nationally, the State ranked 36th in value of nonfuel mineral production. Sales of the State's two leading mineral commodities, construction sand and gravel and crushed stone, increased substantially during the year, and together they accounted for 71% of Wisconsin's total mineral value. Demand for

these two commodities was stimulated by nonresidential and residential construction, for which building permits increased significantly, when compared with 1985 figures. Also contributing to demand was highway construction spending, which was at its second highest level in 5 years. Cement, lime, and dimension stone sales also increased during the year. No metal mining has been reported in the State since 1982, when taconite production ceased.

Table 1.—Nonfuel mineral production in Wisconsin<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones					NA	\$15
Lime	373	\$19,892	341	\$19,001	350	19,715
Peat	9	W	10	W	9	W
Sand and gravel:						
Construction	17,785	38,245	*16,000	*36,000	24,913	59,325
Industrial	1,060	11,821	1,197	14,624	1,194	12,399
Stone:						
Crushed	*15,800	*45,000	14,496	42,380	*18,700	*57,600
Dimension	r *23	r *2,651	22	2,733	*23	*2,878
Combined value of abrasive stone, cement, and values indicated by symbol W	XX	11,527	XX	10,372	XX	12,600
Total	XX	*129,136	XX	125,110	XX	164,532

\*Estimated. †Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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



Table 2.—Nonfuel minerals produced in Wisconsin in 1985, by county<sup>1</sup>

County	Minerals produced in order of value
Ashland	Stone (crushed).
Bayfield	Do.
Brown	Lime, stone (crushed).
Buffalo	Stone (crushed).
Calumet	Stone (crushed), stone (dimension).
Columbia	Sand (industrial), stone (crushed).
Crawford	Stone (crushed).
Dane	Do.
Dodge	Stone (crushed), lime.
Door	Stone (crushed).
Douglas	Lime, cement, stone (crushed).
Dunn	Stone (crushed).
Fond du Lac	Lime, stone (crushed), stone (dimension).
Grant	Stone (crushed).
Green	Do.
Green Lake	Sand (industrial), stone (crushed).
Iowa	Stone (crushed).
Jackson	Sand (industrial).
Jefferson	Stone (crushed).
Juneau	Do.
Kewaunee	Peat.
La Crosse	Stone (crushed).
Lafayette	Do.
Manitowoc	Lime, stone (crushed), stone (dimension).
Marathon	Stone (crushed), stone (dimension).
Marinette	Do.
Milwaukee	Cement, stone (crushed).
Monroe	Stone (crushed).
Oconto	Do.
Outagamie	Do.
Ozaukee	Do.
Pierce	Do.
Polk	Stone (crushed), sand (industrial).
Racine	Stone (crushed).
Richland	Do.
Rock	Do.
St. Croix	Do.
Sauk	Do.
Shawano	Stone (crushed), abrasives.
Sheboygan	Stone (crushed).
Trempealeau	Do.
Vernon	Do.
Walworth	Do.
Washington	Do.
Waukesha	Do.
Waupaca	Stone (crushed), peat, stone (dimension).
Winnebago	Sand (industrial), stone (crushed).
Wood	Stone (crushed), sand (industrial).
Undistributed <sup>2</sup>	Stone (crushed).
	Sand and gravel (construction).

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

Table 3.—Indicators of Wisconsin business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>	
Employment and labor force, annual average:				
Population				
Total civilian labor force	thousands	4,764	4,776	4,785
Unemployment	do	2,390	2,373	2,399
	percent.	7.3	7.2	7.0
Employment (nonagricultural):				
Mining total	thousands	1.9	1.9	2.0
Nonmetallic minerals <sup>1</sup>	do	1.8	1.8	1.8
Manufacturing total	do	518.9	513.9	512.5
Primary metal industries	do	19.9	19.5	19.0
Stone, clay, and glass products	do	8.1	7.9	7.9
Chemicals and allied products	do	9.7	10.0	10.6
Construction	do	63.2	64.6	63.8
Transportation and public utilities	do	91.9	94.2	92.9
Wholesale and retail trade	do	452.8	465.1	477.8
Finance, insurance, real estate	do	101.3	103.8	107.8
Services	do	404.4	419.0	432.9
Government and government enterprises	do	314.7	320.6	325.2
Total <sup>2</sup>	do	1,949.2	1,983.1	2,014.8

See footnotes at end of table.

Table 3.—Indicators of Wisconsin business activity—Continued

	1984 <sup>f</sup>	1985	1986 <sup>p</sup>
Personal income:			
Total ----- millions -----	\$59,836	\$62,792	\$66,549
Per capita -----	\$12,561	\$13,147	\$13,909
Hours and earnings:			
Total average weekly hours, production workers -----	41.1	41.1	41.3
Total average hourly earnings, production workers -----	\$10.0	\$10.3	\$10.4
Earnings by industry: <sup>2</sup>			
Farm income ----- millions -----	\$1,336	\$1,285	\$1,795
Nonfarm ----- do -----	\$40,715	\$42,848	\$45,342
Mining total ----- do -----	\$124	\$160	\$163
Nonmetallic minerals ----- do -----	\$44	\$45	\$44
Manufacturing total ----- do -----	\$13,481	\$13,810	\$14,240
Primary metal industries ----- do -----	\$554	\$522	\$531
Stone, clay, and glass products ----- do -----	\$198	\$199	\$216
Chemicals and allied products ----- do -----	\$316	\$339	\$363
Petroleum and coal products ----- do -----	\$16	\$14	\$14
Construction ----- do -----	\$2,109	\$2,214	\$2,459
Transportation and public utilities ----- do -----	\$2,701	\$2,759	\$2,884
Wholesale and retail trade ----- do -----	\$6,307	\$6,667	\$7,040
Finance, insurance, real estate ----- do -----	\$2,093	\$2,260	\$2,581
Services ----- do -----	\$7,712	\$8,414	\$9,048
Government and government enterprises ----- do -----	\$5,962	\$6,359	\$6,702
Construction activity:			
Number of private and public residential units authorized <sup>4</sup> -----	17,771	20,151	21,824
Value of nonresidential construction <sup>4</sup> ----- millions -----	\$830.9	\$945.1	\$1,101.7
Value of State road contract awards <sup>5</sup> ----- do -----	\$235.9	\$250.2	\$311.5
Shipments of portland and masonry cement to and within the State thousand short tons -----	1,458	1,279	1,522
Nonfuel mineral production value:			
Total crude mineral value ----- millions -----	\$129.1	\$125.1	\$164.5
Value per capita -----	\$27	\$26	\$34

<sup>p</sup>Preliminary. <sup>f</sup>Revised.

<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.

<sup>2</sup>Data may not add to totals shown because of independent rounding.

<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of the inclusion of proprietors' income.

<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.

<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

Expectations for Wisconsin's economy experienced a significant setback in December when Exxon Coal and Minerals Co. indefinitely suspended permitting activities for its proposed zinc-copper mine near Crandon, Forest County. Citing low metal prices, Exxon stated it would maintain its mining properties intact so the permitting process could be resumed when conditions warrant. After spending approximately \$60 mil-

lion, Exxon had nearly reached the final stages of its quest for a mining permit. A final Environmental Impact Statement had been released by the Wisconsin Department of Natural Resources in November and a "master hearing" on the mining project had been scheduled for March 1987. At yearend, Exxon was in the process of reassigning personnel and closing its Rhinelander office.

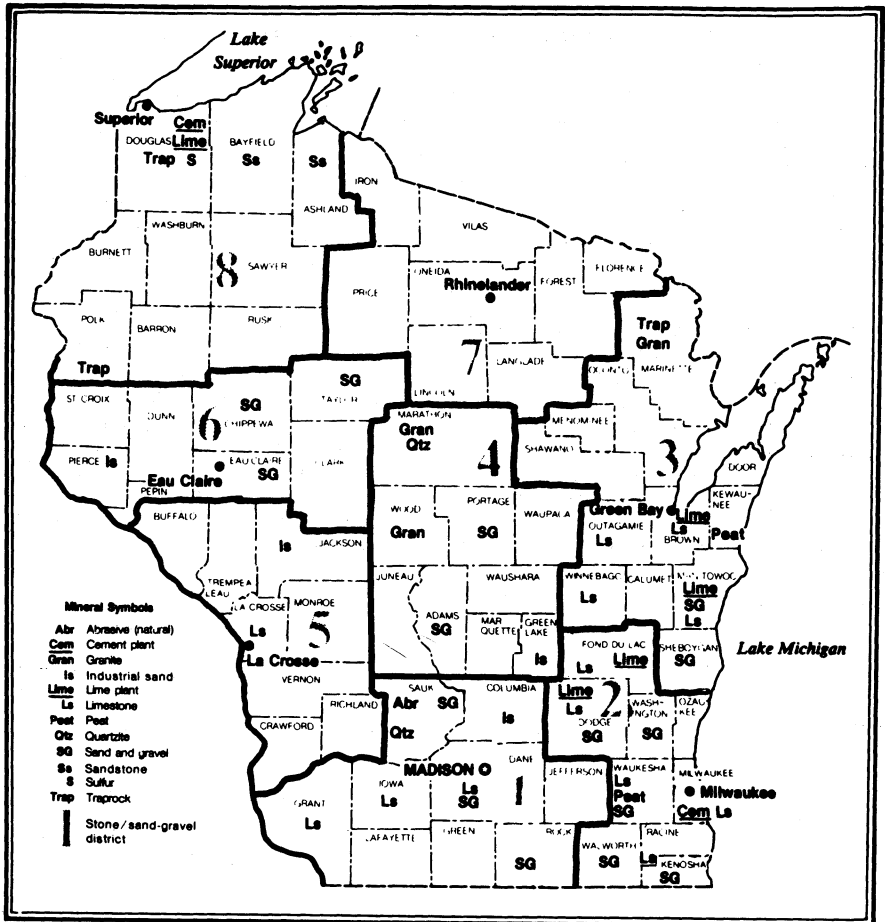


Figure 1.—Principal mineral-producing localities in Wisconsin.

**Employment.**—Wisconsin's Department of Industry, Labor, and Human Relations reported the State's civilian labor work force was 2.4 million in 1986, an improvement over the 2.37 million in 1985. The annual average unemployment rate for the year was 7% or about 169,000 persons compared with 171,000 persons in 1985. Employment in the mining sector increased 5% during the year. Average annual mining wages were \$24,162 in 1986 compared with \$22,518 reported in 1985.

**Exploration Activities.**—Exploration

drilling for metallic minerals continued at a slow pace during the year because of depressed base metal prices and subsequent cutbacks in exploration expenditures. Eleven companies held exploration licenses for all or part of the year; only four companies drilled holes. Oneida County received the most attention with eight holes drilled, followed by Marathon County (four holes); Chippewa, Price, and Taylor Counties (three holes each); and Lincoln County (two holes). A summary of drilling activity is presented in table 4.

Table 4.—Wisconsin: Metallic mineral exploration in 1986

Licensed exploration companies	Number of drill holes	Total footage drilled
Kerr-McGee Corp	1	610
Ernest K. Lehmann & Associates of Wisconsin Inc	10	7,910
Mineralco Inc	3	1,684
Noranda Exploration Inc	9	5,276
Total	23	15,480

Source: Wisconsin Geological and Natural History Survey. Metallic Mineral Exploration in Wisconsin, Summary of 1986 Activity.

Leasing for metallic mineral exploration was also limited during the year. A preliminary survey of county register of deeds offices reported leasing activity commensurate with the low levels recorded in 1985.<sup>4</sup>

**Shipping.**—The Seaway Port Authority of Duluth reported 27.3 million metric tons of waterborne commerce passing through the Port of Duluth-Superior in 1986, a 6% increase over the 25.8 million tons reported in 1985. The shipping season was of normal length; it began on April 3 and ended on

December 29 when the last Great Lakes vessel arrived for winter layup. Shipments and receipts of nonfuel mineral commodities are shown in the tabulation below. Some of the limestone coming into the port was unloaded at CLM Corp.'s lime plant in Superior. Clinker was also received at the cement grinding plant of National Gypsum Co.'s Huron Cement Div. in Superior, which was purchased by LaFarge Corp. at year-end.

	1985 (metric tons)	1986 (metric tons)	Percent change
Dry bulk: <sup>1</sup>			
Canadian imports	185,821	195,121	+5.00
Domestic receipts	847,737	950,141	+12.08
Total	1,033,558	1,145,262	+10.81
Iron ore and concentrates:			
Canadian exports	1,587,571	1,920,675	+20.98
Domestic shipments	13,286,409	12,528,301	-5.71
Total	14,873,980	14,448,976	-2.86

<sup>1</sup>Includes calcium chloride, cement, fertilizer, limestone-limestone products, sodium chloride, etc.

Source: Seaway Port Authority of Duluth, Port of Duluth-Superior. Marine Tonnage Report No. 9, Dec. 1986.

The American Iron Ore Association reported 9.2 million gross tons (railroad weight) of iron ore concentrates handled through Burlington Northern Railroad's loading facility in Superior in 1986. Iron ore and concentrates shipped in 1986 totaled 8.5 million tons. The first vessel was loaded out on April 8, and the last shipment was on December 24. The Duluth, Missabe & Iron Range Railway docks in Duluth handled 5.0 million tons in 1986 compared with 6.1 million tons in 1985. The decline in tonnage was attributed to the strike against USX Corp.'s taconite operations in Minnesota. Shipments began on April 5 and ended on December 24.

The Superior Midwest Energy Terminal transhipped a record high 8.2 million short tons of Montana coal during 1986, surpass-

ing the previous peak of 7.0 million tons shipped in 1985. Except for a small tonnage shipped to the Upper Peninsula Generating Co. in Marquette, MI, all the coal was destined for the St. Clair, MI, generating plant of Detroit Edison Co. Shipments began on April 1 and ended on December 15.

The Port of Green Bay on the western shore of Lake Michigan reported 2.2 million short tons of waterborne commerce in 1986, a slight increase over 1985's tonnage. Major mineral commodities entering the port, in decreasing order of tonnage, were coal, cement, limestone, and salt. Receipts of coal and salt declined when compared with 1985 figures.

Total tonnage handled at the Port of Milwaukee dropped for the second consecutive year, falling 18% below the tonnage

handled in 1985. Large declines were reported for grain (81%), petroleum (79%), and general cargo (53%). Port receipts of selected nonfuel mineral commodities are listed in table 5. Of these commodities, only receipts of salt declined.

**Table 5.—Port of Milwaukee: Selected nonfuel mineral commodity imports\***

(Short tons)		
Commodity	1985	1986
Cement-----	366,776	387,377
Limestone-----	—	21,397
Pig iron-----	33,368	39,639
Salt-----	493,062	490,541
Sand-----	22,799	32,551
Total-----	916,005	971,505

\*Includes Canadian imports and domestic receipts.

Source: 1986 Annual Report, Port of Milwaukee, U.S.A.

**Legislation and Government Programs.**—Although no mineral-related legislation was passed during 1986, two actions—a State supreme court decision and a State attorney general's opinion—had impact on the mineral industry.

In June, the Wisconsin Supreme Court declared the Wisconsin iron ore tax unconstitutional. Ruling in the Burlington Northern Inc. et al versus City of Superior, WI, case, the supreme court declared that the 5-cent-per-ton tax on certain iron ore concentrates handled on the loading docks at Superior constituted a violation of the commerce clause of the U.S. Constitution. At the heart of the case was the State's exemption of iron ore concentrates mined within its boundaries from this same tax. The supreme court found the exemption to be adverse to the interests of interstate commerce and held the entire statute null and void. At issue in the case was approximately \$2 million in tax payments for the period 1977-80. The June 1986 decision reversed a previous Douglas County circuit court decision upholding most of the essential elements of this tax statute (ss. 70.40, Wis. Stats.).

In November, the State's attorney general's office released an opinion (OAG 43-86) concerning the applicability of Wisconsin laws to mining operations on the reservation of the Mole Lake Sokaogon Chippewa Community. Significant metal concentrations had been discovered on the reservation in 1982 by the U.S. Geological Survey, and recent speculation on mining the depos-

it prompted the Governor's staff to request an opinion. Wisconsin's tax on metal mining (net proceeds occupation tax) was found not to be applicable to mining operations on Indian lands. The opinion stated application of the State environmental laws may or may not be allowed depending on analysis of State and Federal laws in context with Indian laws. The State would have a voice in the preparation of an Environmental Impact Statement if one was required.

The State's Mining Investment and Local Impact Fund Board met six times in 1986 to handle disbursement of monies to address mine-related impacts. Fourth and final permit-period payments of \$111,900 were distributed by the board to the towns of Lincoln and Nashville and to the Native American communities of the Sokaogon Chippewa and the Forest County Potawatomi. These payments were mandated by State law when Exxon filed a mining permit application for its proposed Crandon Mine. Payments to these four communities have totaled over \$425,000 since 1982.

Other disbursements in 1986 totaled about \$27,400 to nine eligible parties, which included seven municipalities, one Indian tribe, and one regional mining impact committee. The principal payment not related to the Exxon project was a \$4,400 grant to continue water monitoring of wells in the vicinity of recently closed underground zinc-lead mines in Lafayette County.

The Wisconsin Geological and Natural History Survey continued its basic mapping programs in 1986, including bedrock geologic mapping in the northern half of the State and detailed Pleistocene mapping in several central and northern Wisconsin counties. Several reports were published that included Pleistocene geology maps and reports for Florence and Langlade Counties and bedrock geology maps and reports for Portage and Wood Counties. All of the county reports include maps published at a scale of 1:100,000.

The Federal Government distributed \$621,500 to Wisconsin for its share of funds generated by activities (timbering, mineral leasing, recreation, user fees, etc.) on national forest lands in fiscal year 1986. This compared with \$620,250 in funds the State received in fiscal year 1985. Local governments in Wisconsin received \$376,656 in fiscal year 1986 funds as "payments in lieu of taxes" for Federal tax-exempt lands within their boundaries.

## REVIEW BY NONFUEL MINERAL COMMODITIES

## INDUSTRIAL MINERALS

**Abrasive Stone.**—Baraboo Quartzite Co. Inc. continued to mine quartzite at a small quarry east of Baraboo in Sauk County. Used as a deburring and burnishing medium in metal stamping plants, the product was marketed in several States and foreign countries. Production dropped about 33% during 1986, and value declined about 6%.

**Cement.**—Clinker-grinding facilities were operated by two companies in 1986. National Gypsum, Huron Cement Div., produced portland cement at a plant in Superior, Douglas County, and St. Marys Wisconsin Cement Inc., a subsidiary of St. Marys Cement Ltd., produced both portland and masonry cement at a plant in Milwaukee. Shipments and value of shipments for masonry and portland cement increased substantially because of the demands of the construction industry. Major sales of portland cement were to ready-mixed concrete companies and concrete product manufacturers. Other sales were to building material dealers, highway and other contractors, government agencies, and miscellaneous customers. Most of the cement was shipped in bulk (92%); the rest, in packaged form. All shipments were by truck. Shipments to and within the State were 1.5 million short tons of portland cement and 47,000 tons of masonry cement.

At yearend, LaFarge purchased National Gypsum's grinding facility in Superior.

**Lime.**—Of 34 States, Wisconsin ranked 13th in quantity and 12th in value of lime production in 1986. Three companies produced both hydrated lime and quicklime at five plants. Sales increased slightly during 1986 because of improvements in the steel and agricultural markets. Average value per short ton climbed to \$56.35 in 1986, compared with \$55.64 per ton in 1985. Lime consumption in Wisconsin totaled 97,000 tons of quicklime and 47,000 tons of hydrated lime, changing only slightly from 1985 consumption figures of 99,000 and 46,000 tons, respectively.

**Peat.**—Wisconsin had four peat-producing companies in 1986. Three companies had operations in Waukesha County in the southeastern corner of the State and accounted for most of the State's production (97%). The remaining company had an operation in Kewaunee County near Lake Michigan in east-central Wisconsin. Of 22 producing States, Wisconsin ranked 14th in quantity and 6th in value of peat sales. Most of the State's production (71%) was sold in bulk form. General soil improvement purposes accounted for the majority of sales (63%), followed by use as a seed inoculant (36%). Reed-sedge was the predominant type of peat mined.

**Perlite (Expanded).**—Midwest Perlite Co. expanded crude perlite obtained from Western States at a plant in Outagamie County. Most of the company's product was sold in Wisconsin and adjoining States for horticultural purposes. Sales and value of sales declined about 15% and 9%, respectively.

**Sand and Gravel.**—*Construction.*—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

Nationally, Wisconsin ranked 11th in production of construction sand and gravel. Tonnage and value increased significantly, about 56% and 65%, respectively, because of continued strong demand of the construction industry. Production occurred in 62 of the State's 72 counties and accounted for 36% of the State's total nonfuel mineral value. There were 172 producers with operations at 335 sites. Waukesha County led the State's production with 5.7 million short tons.

In 1986, the U.S. Bureau of Mines began compiling construction sand and gravel statistics by districts for some States. Table 7 presents end-use data for construction sand and gravel production in eight Wisconsin districts depicted in figure 1.

**Table 6.—Wisconsin: Construction sand and gravel sold or used in 1986, by major use category**

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	5,980	\$16,317	\$2.73
Plaster and gunite sands -----	106	323	3.05
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	163	387	2.37
Asphaltic concrete aggregates and other bituminous mixtures -----	1,658	3,607	2.18
Road base and coverings <sup>1</sup> -----	5,485	11,186	2.04
Fill -----	2,719	4,205	1.55
Snow and ice control -----	258	684	2.65
Railroad ballast -----	W	W	1.11
Other -----	219	551	2.52
Other unspecified <sup>2</sup> -----	8,326	22,064	2.65
Total <sup>3</sup> or average -----	24,913	59,325	2.38

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

<sup>1</sup>Includes road and other stabilization (cement and lime).

<sup>2</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.

<sup>3</sup>Data may not add to totals shown because of independent rounding.

**Table 7.—Wisconsin: Construction sand and gravel sold or used by producers in 1986, by use and district**

(Thousand short tons and thousand dollars)

Use	District 1		District 2		District 3		District 4	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products <sup>1</sup> -----	1,586	5,327	2,843	7,134	655	1,452	779	2,011
Asphaltic concrete aggregates and other bituminous mixtures -----	216	489	294	604	295	610	453	937
Road base and coverings <sup>2</sup> -----	348	757	1,309	3,117	769	1,357	1,442	3,099
Fill -----	332	627	1,986	3,102	52	80	226	226
Snow and ice control -----	30	74	94	264	18	98	17	17
Railroad ballast -----	W	W	W	W	W	W	W	W
Other -----	W	W	W	W	W	W	W	W
Other unspecified <sup>3</sup> -----	2,700	9,438	2,536	6,307	922	1,814	320	670
Total <sup>4</sup> -----	5,213	16,711	9,063	20,528	2,711	5,411	3,237	6,959
	District 5		District 6		District 7		District 8	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Concrete aggregates and concrete products <sup>1</sup> -----	W	W	172	462	109	304	W	W
Asphaltic concrete aggregates and other bituminous mixtures -----	W	W	149	288	112	275	W	W
Road base and coverings <sup>2</sup> -----	W	W	715	1,110	296	637	W	W
Fill -----	W	W	60	73	29	31	34	66
Snow and ice control -----	37	78	36	71	17	34	8	48
Railroad ballast -----	W	W	W	W	W	W	W	W
Other -----	W	W	W	W	W	W	2	2
Other unspecified <sup>3</sup> -----	349	999	756	1,393	689	1,367	1,119	2,477
Total <sup>4</sup> -----	387	1,077	1,889	3,398	1,251	2,648	1,162	2,593

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

<sup>1</sup>Includes blocks, bricks, pipe, decorative, etc.; concrete sand; and plaster and gunite sands.

<sup>2</sup>Includes road and other stabilization (cement and lime).

<sup>3</sup>Includes production reported without a breakdown by end use, estimates for nonrespondents, and data indicated by symbol W.

<sup>4</sup>Data may not add to totals shown because of independent rounding.

**Industrial.**—Four companies produced sand for industrial purposes in six counties. Major sales of industrial sand were for foundry uses, glass manufacturing, hydraulic fracturing, and sandblasting. Average value of sales per short ton dropped to \$10.38 in 1986, compared with \$12.22 per ton in 1985.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

In April, Martin Marietta Corp., the Nation's second largest crushed stone producer, acquired Weaver Construction Co. of Alden, IA. Weaver operated a large railroad ballast quarry near Rock Springs, WI, for the Chicago and Northwestern Railroad.

**Sulfur (Recovered).**—Murphy Oil USA Inc. recovered sulfur as a byproduct of its oil refining operations at Superior, Douglas County. Sales and value of sales increased about 21% in 1986.

**Vermiculite (Exfoliated).**—Crude vermiculite from out-of-State sources was exfoliated by Koos Inc. at its plant in Kenosha. Sales increased about 6% during 1986, and average value per short ton increased about 27%. Major sales were for agricultural purposes. Lesser quantities were used for loose fill and packing insulation and as concrete, plaster, and roofing aggregates.

**METALS**

One company, DCS Color & Supply Co. Inc., in Milwaukee, processed and sold natural iron oxide pigments for foundry uses, colorants in cement and construction materials, cosmetics, and paint and coatings. Production increased slightly during the year.

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<sup>2</sup>Associate professor, Minerals Information, Wisconsin Geological and Natural History Survey, Madison, WI.

<sup>3</sup>Editorial assistant, Bureau of Mines, Minneapolis, MN.

<sup>4</sup>Evans, T. J. *Metallic Mineral Exploration in Wisconsin, Summary of 1986 Activity.* Wis. Geol. and Nat. Hist. Surv., 1987, 4 pp.

**Table 8.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Abrasive stone:</b>			
Baraboo Quartzite Co. Inc.-----	Box 123 Baraboo, WI 53913	Quarry and plant	Sauk.
<b>Cement:</b>			
National Gypsum Co., Huron Cement Div.	4000 Town Center Suite 2000 Southfield, MI 48075	Grinding plant --	Douglas.
St. Marys Wisconsin Cement Inc., a subsidiary of St. Marys Cement Ltd.	9333 Dearborn St. Detroit, MI 48209	---do-----	Milwaukee.
<b>Iron oxide pigments (finished):</b>			
DCS Color & Supply Co. Inc.-----	2011 South Allis St. Milwaukee, WI 53207	Plant-----	Do.
<b>Lime:</b>			
CLM Corp -----	12th Ave. West and Waterfront St. Duluth, MN 55802	---do-----	Douglas.
Rockwell Lime Co -----	4223 Rockwood Rd. Manitowoc, WI 54220	---do-----	Manitowoc.
Western Lime & Cement Co ---	Box 57 West Bend, WI 53095	Plants -----	Brown, Dodge, Fond du Lac.
<b>Peat:</b>			
Bogda's Top Soil & Excavating Co.	12600 West Cleveland Ave. New Berlin, WI 53151	Bog and plant---	Waukesha.
Certified Peat & Sod Inc.-----	19000 West Lincoln Ave. New Berlin, WI 53151	---do-----	Do.
Demilco Inc., a division of Nitragin Co. Inc.	3101 West Custer Ave. Milwaukee, WI 53209	---do-----	Do.
Honest To Peat Inc.-----	Route 2 Algoma, WI 54201	Bog -----	Kewaunee.
<b>Perlite (expanded):</b>			
Midwest Perlite Co -----	4280 Parkway Blvd. Appleton, WI 54915	Plant-----	Outagamie.
<b>Sand and gravel:</b>			
<b>Construction:</b>			
Janesville Sand & Gravel Co., Lycon Inc.	Box 427 Janesville, WI 53545	Pits and plants --	Columbia, Dane, Rock.
Johnson Sand & Gravel Inc --	N8 W22590 Johnson Dr. Waukesha, WI 53186	---do-----	Waukesha.
Edward Kraemer & Sons Inc	1 Plainview Rd. Plain, WI 53577	---do-----	Various.
Mann Bros. Sand & Gravel Inc.	Box 48 Elkhorn, WI 53121	---do-----	Columbia, Crawford, Kenosha, Rock, Wal- worth.



Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sand and gravel —Continued</b>			
<b>Construction —Continued</b>			
Arthur Overgaard Inc -----	Box 87 Elroy, WI 53929	Pits and plants --	Adams and Juneau.
Park View Sand & Gravel Inc.	S2L West Westmoreland Rd. Waukesha, WI 53186	Pit and plant ----	Waukesha.
Wisota Sand & Gravel Co. --	Box 1268 Eau Claire, WI 54701	Pits and plants --	Barron, Sawyer, Washington.
<b>Industrial:</b>			
Badger Mining Corp -----	Box 97 Fairwater, WI 53931	----do-----	Green Lake and Jackson.
A. F. Gelhar Co. Inc. -----	Box 209 Berlin, WI 54923	----do-----	Waupesa and Winnebago.
Treco Sales Inc. -----	Box 38 Bay City, WI 54723	Underground mine and plant.	Pierce.
Unimin Corp. -----	258 Elm St. New Canaan, CT 06840	Pit and plant ----	Columbia.
<b>Stone (1985):</b>			
<b>Crushed:</b>			
<b>Granite:</b>			
Boon Construction Inc -	Route 3, Box 61-H Neillsville, WI 54456	Quarry and plant	Wood.
Gary Charneski Exca- vating Co.	626 Highway B Mosinee, WI 54455	----do-----	Marathon.
<b>Limestone and dolomite:</b>			
Daanen & Janssen -----	Box 127 De Pere, WI 54115	Quarries and plants.	Brown.
4X Corp -----	Box 509 Neeah, WI 53929	----do-----	Calumet, Fond du Lac, Win- nebago.
C. C. Linck Inc -----	1226 North Center St. Beaver Dam, WI 53916	----do-----	Various.
Arthur Overgaard Inc. --	Box 87 Elroy, WI 53929	----do-----	Buffalo, Juneau, La Crosse, Monroe, St. Croix.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, IL 60525	----do-----	Milwaukee, Racine, Waukesha, Winnebago.
<b>Sandstone and quartzite:</b>			
Martin Marietta Aggre- gates, Central Div.	Box 30013 Raleigh, NC 27622	Quarry and plant	Sauk.
Minnesota Mining & Manufacturing Co.	3M Center St. Paul, MN 55101	----do-----	Marathon.
<b>Traprock (basalt):</b>			
GAF Corp -----	Box 630 Pembine, WI 54156	----do-----	Marinette.
TCI Traprock Inc. -----	Box 517 Dresser, WI 54009	----do-----	Polk.
<b>Dimension:</b>			
<b>Granite:</b>			
Anderson Bros. & Johnson Co.	Box 26 Wausau, WI 54401	Quarries and plant	Marathon and Marinette.
Cold Spring Granite Co -	202 South 3d Ave. Cold Spring, MN 56320	Quarry -----	Marathon.
Lake Wausau Granite Co.	Box 397 Wausau, WI 54401	Quarry and plant	Do.
Monumental Sales and Manufacturing Co. Inc.	Box 667 St. Cloud, MN 56302	----do-----	Do.
<b>Limestone:</b>			
Buechel Stone Center Inc	Box 907 Fond du Lac, WI 54935	Quarries and plant	Calumet and Fond du Lac.
R. & T. Quality Stone Inc. <sup>1</sup>	Box 182 Lannon, WI 53046	Quarry and plant	Waukesha.
Valders Lime & Stone Co. Inc.	Box 35 Valders, WI 54245	----do-----	Manitowoc.
Wislanco Stone Co. Inc -	Box 312 Lannon, WI 53046	----do-----	Waukesha.
<b>Sulfur (recovered):</b>			
Murphy Oil USA Inc. -----	Box 2066 Superior, WI 54880	Byproduct sulfur recovery plant.	Douglas.
<b>Vermiculite (exfoliated):</b>			
Koos Inc -----	4500 13th Ct. Kenosha, WI 53140	Plant -----	Kenosha.

<sup>1</sup>Also crushed limestone.

# The Mineral Industry of Wyoming

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

By W. L. Rice<sup>1</sup> and Gary B. Glass<sup>2</sup>

The value of Wyoming's 1986 nonfuel mineral production increased slightly to \$556.1 million from the \$552.5 million recorded in 1985. A significant increase in the value of sodium carbonate (soda ash) production was largely balanced out by a substantial decrease in the value of bentonite production, and smaller decreases in the value of cement, gypsum, lime, and crushed stone production.

Nearly all of the State's nonfuel mineral production during the year was industrial

minerals. Soda ash was the leading commodity in terms of value, followed by bentonite, construction sand and gravel, and cement. Wyoming ranked first nationally in bentonite and soda ash production, and was third in the production of Grade-A helium and elemental sulfur. The State was 14th in the Nation in value of nonfuel minerals production, identical to its 1985 ranking. The value of nonfuel minerals per capita was about \$1,097, compared with the national per capita value of \$98.

Table 1.—Nonfuel mineral production in Wyoming<sup>1</sup>

Mineral	1984		1985		1986	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays ----- thousand short tons	2,628	\$67,921	2,302	\$64,146	1,762	\$51,823
Gem stones-----	NA	225	NA	225	NA	225
Gypsum----- thousand short tons	376	2,618	576	4,488	W	W
Lime ----- do	W	W	W	W	25	1,689
Sand and gravel (construction) ----- do	4,586	13,372	*3,500	*11,000	3,377	10,977
Stone (crushed) ----- do	*1,900	*7,600	*2,030	*7,329	* 2,700	* 5,900
Combined value of beryllium concentrates (1986), cement (masonry, 1986, and portland), helium (Grade-A, 1986), sodium carbonate (natural), stone (crushed granite, 1985-86), and values indicated by symbol W	XX	458,187	XX	465,275	XX	485,480
Total -----	XX	549,923	XX	552,463	XX	556,094

<sup>1</sup>Estimated. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

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

<sup>3</sup>Excludes certain stones; value included with "Combined value" figure.

**Table 2.—Nonfuel minerals produced in Wyoming in 1985, by county<sup>1</sup>**

County	Minerals produced in order of value
Albany -----	Cement, stone (crushed), clays, gypsum.
Big Horn -----	Clays, gypsum, lime.
Crook -----	Clays, stone (crushed).
Fremont -----	Stone (crushed).
Goshen -----	Lime.
Johnson -----	Clays.
Laramie -----	Stone (crushed).
Natrona -----	Clays.
Park -----	Gypsum.
Platte -----	Stone (crushed).
Sheridan -----	Do.
Sweetwater -----	Sodium carbonate.
Uinta -----	Clays.
Washakie -----	Clays, lime.
Weston -----	Clays.
Undistributed <sup>2</sup> -----	Sand and gravel (construction), gem stones, helium (Grade A).

<sup>1</sup>No production of nonfuel mineral commodities was reported for counties not listed.

<sup>2</sup>Data not available by county for minerals listed.

**Trends and Developments.**—The combination of a marginal price improvement, increased shipments to export markets, greater operational efficiencies, and closure of the one remaining domestic synthetic sodium carbonate plant contributed to the 1986 increase in Wyoming's soda ash production. A trend toward slightly decreased domestic soda ash consumption (down 2% in 1986), caused largely by substitution of plastic for glass products, appears to have been more than compensated for by increased penetration of foreign markets, especially in Asia.

The significant downturn in Wyoming's 1986 bentonite production reflected the continued slump in the petroleum and steel industries, where bentonite is used in well-drilling mud and in iron ore pelletizing. Low petroleum prices during the year and an oversupply of natural gas resulted in approximately 280 fewer wildcat wells and 1,000 fewer total wells being drilled in the State than in 1985. This trend, prevalent throughout the domestic petroleum industry, resulted in a substantial drop in bentonite demand and production.

**Employment.**—Overall mining employment for 1986, including petroleum and coal workers, declined to 19,500 from the 25,100 reported in 1985. According to the Wyoming Employment Security Commission, average weekly earnings for the State's mineral industry production workers rose to \$595.86, up from the \$586.76 recorded in 1985. The average hourly wage for the State's mineral industry workers was

\$14.13, compared with the national average of \$12.42 per hour; mineral industry workers were again the highest paid group in the private nonfarm industries wage sector.

**Environment.**—Cleanup of a tailings pile from an old copper smelter near Riverside, Carbon County, was accomplished during 1986. The project involved the removal, transportation, and burial of 40,000 cubic yards of mill tailings from the site of the Grand Encampment copper smelter. The \$455,000 undertaking was coordinated by the Wyoming Department of Environmental Quality (DEQ) under its Abandoned Mine Lands Program.

Andover Resources Corp., new owners of the Ferris-Haggerty copper-gold mine, worked to develop a solution to a copper-pollution problem in Haggerty Creek. Copper sulfate originating in the old mine workings is present in mine water flowing into the creek, where the dissolved copper adversely affects the native trout population. The DEQ gave Andover Resources until January 1, 1987, to arrive at a solution to the problem.

The State's congressional delegation urged the U.S. Department of Energy to consider cleanup of the Susquehanna uranium mill tailings pile, near St. Stephens Mission, Fremont County. The State wanted the 900,000 tons of inactive uranium mill wastes moved to American Nuclear's Gas Hills waste disposal facility.

**Exploration Activities.**—The 1986 level of exploration in Wyoming, largely for precious metals and industrial minerals, was down from that of 1985. Exploration for platinum-group metals occurred in two layered mafic rock complexes in the Medicine Bow Mountains in the southeastern part of the State. International Platinum Corp. acquired 4,800 acres of land surrounding the New Rambler Mine, Carbon County, for platinum exploration; past production of copper concentrates from the mine contained significant amounts of palladium and platinum. Two other mining companies reportedly explored for platinum-group metals during the year in the same region.

Consolidated McKinney Resources Inc. conducted a dewatering and core-drilling program at the long dormant Carissa gold mine near South Pass City, Fremont County. The Carissa Mine, Wyoming's second largest gold producer, was being evaluated as a potential low-grade, mass-minable gold deposit.

Table 3.—Indicators of Wyoming business activity

	1984 <sup>F</sup>	1985	1986 <sup>P</sup>
<b>Employment and labor force, annual average:</b>			
Population ----- thousands .....	513	510	507
Total civilian labor force ----- do .....	255	250	249
Unemployment ----- percent .....	6.3	7.1	9.0
<b>Employment (nonagricultural):</b>			
Mining total ----- thousands .....	27.9	25.1	19.5
Metal mining <sup>1</sup> ----- do .....	1.3	.9	.7
Nonmetallic minerals except fuels <sup>1</sup> ----- do .....	4.0	3.9	3.8
Coal mining <sup>1</sup> ----- do .....	5.7	5.7	5.1
Oil and gas extraction <sup>1</sup> ----- do .....	16.9	14.6	9.9
Manufacturing total ----- do .....	8.0	8.0	8.0
Stone, clay, and glass products <sup>1</sup> ----- do .....	1.1	1.0	.9
Chemicals and allied products <sup>1</sup> ----- do .....	.3	.3	.3
Petroleum and coal products ----- do .....	1.1	1.0	.9
Construction ----- do .....	14.1	18.2	17.0
Transportation and public utilities ----- do .....	15.8	15.0	14.2
Wholesale and retail trade ----- do .....	46.4	46.9	45.5
Finance, insurance, real estate ----- do .....	8.0	8.1	8.1
Services ----- do .....	33.1	33.4	33.4
Government and government enterprises ----- do .....	50.9	52.2	53.3
Total <sup>2</sup> ----- do .....	204.3	206.9	199.1
<b>Personal income:</b>			
Total ----- millions .....	\$6,284	\$6,595	\$6,485
Per capita ----- do .....	\$12,252	\$12,940	\$12,781
<b>Hours and earnings:</b>			
Total average weekly hours, production workers ----- do .....	39.5	40.9	39.0
Mining ----- do .....	43.4	43.1	42.8
Total average hourly earnings, production workers ----- do .....	\$9.1	\$9.6	\$9.7
Mining ----- do .....	\$13.3	\$13.7	\$14.4
<b>Earnings by industry:<sup>3</sup></b>			
Farm income ----- millions .....	\$21	\$34	\$37
Nonfarm ----- do .....	\$4,783	\$5,010	\$4,804
Mining total ----- do .....	\$1,032	\$1,003	\$826
Metal mining ----- do .....	\$49	\$38	\$33
Nonmetallic minerals except fuels ----- do .....	\$158	\$159	\$148
Coal mining ----- do .....	\$272	\$293	\$273
Oil and gas extraction ----- do .....	\$554	\$512	\$372
Manufacturing total ----- do .....	\$198	\$198	\$200
Primary metal industries ----- do .....	\$8	\$6	\$6
Stone, clay, and glass products ----- do .....	\$27	\$26	\$23
Chemicals and allied products ----- do .....	\$9	\$12	\$13
Petroleum and coal products ----- do .....	\$48	\$43	\$45
Construction ----- do .....	\$432	\$568	\$541
Transportation and public utilities ----- do .....	\$532	\$529	\$504
Wholesale and retail trade ----- do .....	\$685	\$704	\$667
Finance, insurance, real estate ----- do .....	\$169	\$178	\$187
Services ----- do .....	\$656	\$693	\$714
Government and government enterprises ----- do .....	\$1,057	\$1,117	\$1,144
<b>Construction activity:</b>			
Number of private and public residential units authorized <sup>4</sup> ----- do .....	1,649	1,167	876
Value of nonresidential construction <sup>4</sup> ----- millions .....	\$88.6	\$83.3	\$192.3
Value of State road contract awards <sup>5</sup> ----- do .....	\$171.1	\$174.5	\$207.5
Shipments of portland and masonry cement to and within the State ----- thousand short tons .....	396	415	343
<b>Nonfuel mineral production value:</b>			
Total crude mineral value ----- millions .....	\$549.9	\$552.5	\$556.1
Value per capita ----- do .....	\$1,070	\$1,083	\$1,097

<sup>P</sup>Preliminary. <sup>F</sup>Revised.<sup>1</sup>Bureau of Economic Analysis, Regional Economic Measurement Division, U.S. Department of Commerce.<sup>2</sup>Data may not add to totals shown because of independent rounding.<sup>3</sup>Includes wages and salaries, proprietors' income, and other labor income; cannot be directly related to employment because of inclusion of proprietors' income.<sup>4</sup>Construction Review, International Trade Administration, U.S. Department of Commerce, May-June 1987, pp. 26-27, 35-36.<sup>5</sup>Highway and Heavy Construction Magazine, Jan. 1986, p. 32.

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

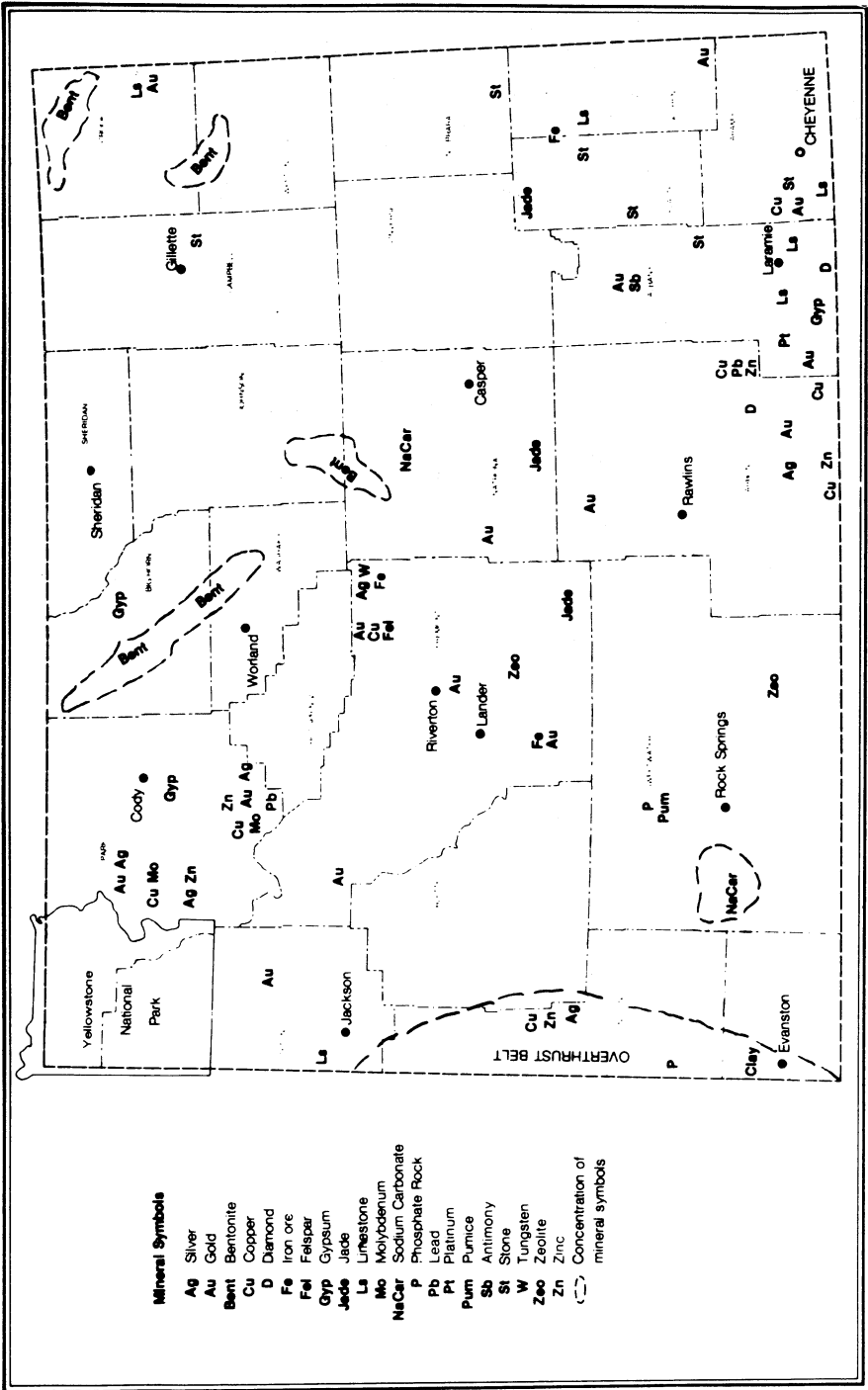


Figure 1.—Principal mineral-producing localities in Wyoming.

In 1986, the Geological Survey of Wyoming (GSW) and several private companies investigated gold placer deposits in the Meadow Gulch and McGraw Flats areas near South Pass City and sandstone-shale gold anomalies in some Wyoming basins; exploration for volcanogenic massive sulfide deposits was reported in the Hartville Uplift.

Andover Resources announced plans to return the Ferris-Haggerty copper-gold mine to production. The mine, developed in an enriched stratabound copper deposit in quartzite, last produced in 1908.

Henrietta Mines and Kirkwood Oil and Gas Co. applied to the State Board of Land Commissioners for reduced royalties on the State-owned Copper King Mine west of Cheyenne. The Copper King deposit is a large-tonnage low-grade gold-copper occurrence; based on preliminary drilling, the deposit reportedly contains mass-minable resources of up to 35 million short tons, grading 0.022 troy ounce of gold per ton and 0.21% copper.

The Tivan Co. drilled twenty-four 100-foot holes in a vanadium-bearing titaniferous magnetite deposit in the Strong Creek-Iron Mountain area, Albany County.

Exploration continued in the State for natural sulfur deposits. Wyoming Sulfur Corp. planned a drilling program for a deposit west of Thermopolis, in Hot Springs County.

Exploration for diamonds continued on a reduced scale in the southern Laramie Range, and a kimberlite "diatreme-like" structure was found by the GSW in the Pole Mountain-Happy Jack area.

**Legislation and Government Programs.**—The total taxable valuation of property in Wyoming was \$7.8 billion, down 7% from that of 1985. Minerals accounted for slightly more than 70% of this total: oil (37%), natural gas (16%), coal (16%), and trona (soda ash) and other minerals (1%). Minerals paid \$362.2 million in ad valorem taxes on production, of which trona and other nonfuel minerals contributed \$9.2 million of that total. Severance taxes collected on mineral production amounted to \$259 million; \$5.5 million was derived from trona and other nonfuel minerals. Sales and use taxes on minerals totaled \$34 million for the year. All mineral income—taxes,

rents, and royalties—accruing to Wyoming totaled about \$905 million, by far the most important source of income to the State.

During 1986, the U.S. Bureau of Land Management (BLM) had 53 solid mineral leases in effect in the State, covering 74,777 acres. These leases did not include those for coal. Specific mineral commodities included were bentonite, phosphate rock, trona, and uranium. Seven prospecting permits for bentonite, covering 2,110 acres of Federal land, were active during the year. Wyoming received \$145.4 million as receipts from the Mineral Leasing Act; most of the royalties were derived from oil, natural gas, and coal production.

The Office of Surface Mining (OSM), U.S. Department of the Interior, awarded Wyoming a \$12.9 million grant to reclaim abandoned bentonite mines in Crook and Weston Counties. OSM has awarded Wyoming more than \$100 million in the last 3 years for reclaiming abandoned mines.

An unsuccessful 1985 proposal for a large-scale interagency land exchange between the U.S. Forest Service and the BLM was reintroduced in early 1986. The proposed exchange of management responsibility, advanced as a means to improve efficiency and cut costs, would affect about 5.2 million acres of Federal land in Wyoming. Enabling legislation to implement the land exchange had not been introduced by yearend.

The Mining and Mineral Resources Research Institute at the University of Wyoming received a grant of \$142,000 through the U.S. Bureau of Mines. The university has been funded for a total of \$1,385,406 since inception of the Mineral Institute program in 1978.

The GSW received \$67,000 in U.S. Geological Survey grant funds in fiscal year 1986. The eight survey grants covered cooperative geologic mapping projects, mapping of landslide areas in Wyoming, and entry of data into the Survey's National Coal Resources Data System. In 1986, the GSW completed a study related to reclamation work on the Sunrise iron ore mine and an investigation of 10 significant tar sand and heavy oil occurrences in the State. The GSW published a total of 53 reports, maps, and posters in fiscal year 1986, including 5 Information Circulars, 15 maps, 19 open-file reports, and 4 Reports of Investigation.

## REVIEW BY NONFUEL MINERAL COMMODITIES

### INDUSTRIAL MINERALS

**Cement.**—Completion in 1985 of the final segment of Wyoming's 914-mile interstate highway system and a temporary reduction in production capacity of the State's only cement plant contributed to a significant decline in the State's cement production in 1986. Production decreased nearly 33% in quantity and almost 31% in value from the totals recorded in 1985.

Early in the year, Centex Cement Enterprises Inc. purchased Monolith Portland Cement Co.'s cement plant at Laramie, Albany County. Centex established a new subsidiary, Mountain Cement Co., to own and operate the plant. Mountain Cement began a program to modernize and update the plant, including conversion from a wet-process to a dry-process operation. The bulk of Mountain Cement's 1986 production was general use, moderate heat Types I and II gray portland cement; lesser tonnages of oil well and masonry cements also were produced. Portland cement was used by ready-mixed concrete companies (86%), highway contractors (8%), concrete product manufacturers (3%), and building material dealers and other contractors (3%).

Mountain Cement's plant produced cement from clinker brought in from out of State; locally obtained gypsum was used. Natural gas was used for fuel, and electricity was purchased for energy. Finished portland cement was transported in bulk by rail to terminal, and in bulk and containers by truck to consumers.

**Clays.**—Sodium bentonite comprised nearly 99% of Wyoming's clay production; the State again ranked first in bentonite production, accounting for almost 62% of the Nation's output for the year. Wyoming's bentonite production, primarily processed for oil and gas well drilling muds, reflected the stagnant state of that industry by decreasing 23% in tonnage and 19% in value from that credited in 1985.

Bentonite production was reported by 7 companies from 119 pits in 6 counties; 92% of the State's production, however, came from Big Horn, Crook, and Weston Counties. Employment in bentonite production fell by 179 people to a 476-person total; in 1981, nearly 1,200 workers had been employed.

Wyoming bentonite producers increasingly diversified their product lines to reduce dependence on the petroleum industry. Black Hills Bentonite (Kaycee Bentonite Corp.) developed a granular product better suited for foundry applications, and Ameri-

can Colloid Co.'s plants at Lovell, WY, and Belle Fourche, SD, produced bentonite-filled cardboard waterproofing building panels and a product that replaced lime in mortar mixes.

NL Industries Inc. closed its bentonite processing plant at Lovell at yearend. Employment had declined from 45 workers at peak production in 1984 to 10 workers at the time of closure; the company had no plans to dismantle the facility.

Dresser Industries Inc. finalized a joint venture in December with the Halliburton Co. The joint venture, M-I Drilling Fluids Co., combined the drilling fluid businesses of the two companies to increase economies of scale and thereby restore the economic viability of operations. Dresser owns 60% of the joint venture.

**Gem Stones.**—Alluvial jade was collected from scattered localities in an east-west-trending band enclosing the Granite Mountains in southern Fremont and southwestern Natrona Counties. Discussions with a China trade delegation in 1986 may lead to exports of Wyoming jade to the Chinese jewelry industry.

The Lac Minerals Ltd.-Mobil Oil Corp. joint venture continued exploration for diamonds in the State Line District in southern Albany County. One kimberlite occurrence evaluated was determined to contain an adequate diamond grade, but the quality of the stones was found to be noncommercial. The GSW investigated potentially diamond-bearing rocks in the Leucite Hills, Sweetwater County; rocks from this area had reportedly been examined by Soviet researchers and by a Belgian-owned firm interested in their diamond potential.

**Gypsum.**—The quantity of crude gypsum mined in Wyoming increased, but the value, following a national trend, decreased. The production increase reflected a period of relative prosperity in the building and construction industries, which consumed all the State's gypsum production.

Crude gypsum was produced by three companies in three counties. Mountain Cement mined gypsum at Red Mountain, Albany County; the mined product was used in cement manufacture at the Mountain Cement plant, Laramie. Georgia-Pacific Corp., Gypsum Div., at Lovell, Big Horn County, and the Celotex Div. of Jim Walter Corp., at Cody, Park County, mined and calcined gypsum for wallboard production.

**Helium (Grade-A).**—Grade-A helium production commenced in Wyoming in 1986;

the State was one of four to process Grade-A helium and ranked third in production. Exxon Co. U.S.A. extracted the helium as a part of its natural gas operations in the Riley Ridge Gasfield in southwestern Wyoming. The helium was sold to private industry, with a royalty payment to the Federal Government. The U.S. Bureau of Mines estimated that the Riley Ridge Field contained more than 100 billion cubic feet of helium in association with natural gas.

**Lime.**—Lime production in the State decreased nearly 11% in quantity and about 8% in value. Quicklime for sugar manufacture was produced by two companies in three counties—The Great Western Sugar Co. at Lovell, Big Horn County, and the Holly Sugar Corp. at Torrington, Goshen County, and at Worland, Washakie County.

**Perlite (Expanded).**—Expanded perlite production was reported by Harborlite Corp. from its processing plant near Green River, Sweetwater County. Harborlite supplied perlite to the trona industry for use in filters at soda ash refining plants.

**Phosphate Rock.**—No production of phosphate rock was reported for Wyoming in 1986. In midyear, Chevron USA Inc. started production at its \$100 million phosphate fertilizer plant at Rock Springs, Sweetwater County. The facility has a 350,000-short-ton annual dry-product capacity and has a superphosphoric acid plant. Phosphate rock from Chevron's mine at Vernal, UT, was transported by a 95-mile-long slurry pipeline to the plant, and Wyoming sulfur from Chevron's Carter Creek natural gas plant was used in the manufacturing process. The 200 employees at the Rock Springs plant represent a \$6 million annual payroll.

FMC Corp. operated its Green River sodium tripolyphosphate plant during the year, using elemental phosphorus from its plant at Pocatello, ID. FMC began an expansion program in 1986 to double the capacity of the Green River facility; completion is scheduled for mid-1987. The expansion is part of FMC's plans to enlarge its output from this western phosphate plant to efficiently supply detergent manufacturers who are consolidating their production in the Midwest.

**Sand and Gravel (Construction).**—Construction sand and gravel production is surveyed by the U.S. Bureau of Mines for even-numbered years only; this chapter contains actual data for 1984 and 1986 and estimates for 1985. Data for odd-numbered years are based on annual company estimates.

The 1986 output of sand and gravel in the State declined by about 26% in quantity and by 18% in value from that reported in 1984, when the last complete canvass was taken. Substantial production decreases in the concrete aggregate and asphaltic concrete aggregate categories reflected decreased highway construction in Wyoming.

Construction sand and gravel production was reported from 55 operations in 22 counties. Albany, Campbell, Laramie, Natrona, and Platte Counties accounted for more than 52% of the total production reported. Major uses were for road base and coverings (40%), other uses (25%), concrete aggregates (16%), and asphaltic concretes (16%); the bulk of Wyoming's construction sand and gravel production was transported by truck.

Table 4.—Wyoming: Construction sand and gravel sold or used in 1986, by major use category

Use	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregates (including concrete sand) -----	540	\$2,144	\$3.97
Plaster and gunite sands -----	W	W	3.00
Concrete products (blocks, bricks, pipe, decorative, etc.) -----	13	23	2.15
Asphaltic concrete aggregates and other bituminous mixtures -----	531	2,599	4.89
Road base and coverings -----	1,356	3,575	2.64
Fill -----	61	127	2.08
Snow and ice control -----	26	100	3.85
Railroad ballast -----	W	W	11.00
Other -----	203	240	1.18
Other unspecified <sup>1</sup> -----	647	2,164	3.34
Total or average -----	3,377	10,977	3.25

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

<sup>1</sup>Includes production reported without a breakdown by end use and estimates for nonrespondents.



**Sodium Carbonate.**—Wyoming accounted for nearly 88% of the Nation's natural soda ash production; the State's production increased by 10% in quantity and by about 5% in value from that achieved in 1985. The rise in production was due to increased shipments to foreign consumers, a greater demand for flat glass and fiberglass, and increased soda ash consumption in soaps and detergents. Production was reported by five trona mines and associated soda ash processing plants in the Green River trona district of Sweetwater County. According to Wyoming's State Inspector of Mines, the 1986 underground trona mine output for the five producing companies was as follows: FMC Wyoming Corp., 3.75 million short tons; General Chemical Co., 3.06 million tons; Stauffer Chemical Co. of Wyoming, 2.61 million tons; Tg Soda Ash Operations, 2.04 million tons; and Tenneco Minerals Co., 1.51 million tons. These levels of production represented about 82% of capacity.

During the year, Wyoming's major role in the domestic soda ash industry increased with the permanent closure of General Chemical's 700,000-short-ton-per-year Solvay process synthetic soda ash plant at Syracuse, NY. Kerr-McGee Chemical Corp. announced plans to terminate production in 1987 at its Westend, CA, plant, leaving its Argus plant as the only soda ash producer in California. These closures should be of long-term benefit to the Wyoming soda ash industry.

Production from FMC's new \$30 million solution mining system increased to approximately 10% to 15% of the company's total trona output in 1986. FMC mined the most deeply seated trona beds—2,300 feet underground—by solution mining techniques because of safety and cost considerations. Trona recovery by conventional mechanical mining methods is about 45%, whereas recovery by solution mining is about 30% and production costs are cut by an estimated 25%. Tg Soda Ash experimented with solution mining during the year and has trona leases available to recover the mineral by the solution process. Other mining methods used in the district were conventional drill-blast-haul, continuous miner, and longwall and shortwall cutting systems.

General Chemical (formerly Allied Chemical Co.) sold a 49% interest in its Wyoming soda ash operation to Australia Consolidated Industries Ltd., an Australian glass-packaging manufacturer. In August, Gen-

eral Chemical laid off 90 workers, citing declining sales of soda ash; sales were largely to manufacturers of glass containers. Total 1986 employment in Wyoming's Green River soda ash industry, including baking soda, sodium tripolyphosphate, and sodium sesquicarbonate manufacture, was about 3,100 people; their annual payroll, exclusive of fringe benefits, totaled more than \$128 million.

Church & Dwight Inc. completed a \$12 million dry-laundry-detergent plant at its soda ash product facility west of Green River. The new plant will use 70,000 tons of soda ash annually, to be supplied by General Chemical.

The first BLM trona lease sale in Wyoming in more than 19 years netted the Federal Government in excess of \$1 million in bonus bids on two tracts of public land in Sweetwater County. Tenneco Minerals was high bidder on 1,933 acres at \$245 per acre; Church & Dwight bid a high of \$316.33 per acre on a 1,696-acre tract.

**Stone.**—Stone production is surveyed by the U.S. Bureau of Mines for odd-numbered years only; this chapter contains estimates for 1984 and 1986 and actual data for 1985. Data for even-numbered years are based on annual company estimates.

Limestone for cement manufacture, concrete aggregate, highway construction applications, and other uses was quarried by four companies in four counties. Granite used for various crushed stone applications was quarried by three companies in three of the State's counties during the year.

Clinker (scoria) or natural slag was mined by Sierra Construction Co. at Linch, Johnson County, and by Tongue River Stone near Sheridan, Sheridan County.

Basins Engineering Co., which quarried white dolomite for decorative stone at its operation near Wheatland, Platte County, was purchased by Georgia Marble Co. in May.

**Sulfur (Recovered).**—Wyoming was third of 26 States producing recovered elemental sulfur; production in 1986 decreased about 3% in quantity and 5% in value from the 1985 totals. The State's sulfur was produced by energy companies as a byproduct of processing natural gas from the Overthrust Belt of southwestern Wyoming. Eight companies reported production from operations in eight counties. More than 80% of the State's 1986 production was credited to Amoco Production Co.'s Whitney Canyon operation and Chevron's Carter Creek facility, both in Uinta County.

A sulfur trucking company, Zaneca Bulk Systems International, was established in Riverton. The company hauled sulfur from Amoco's Whitney Canyon operation and from other southwestern Wyoming natural gas plants to a Burlington Northern railroad at Bonneville. Zaneca also operated leased loading facilities at Shoshoni, which enabled shipments to be made on the Chicago and Northwestern Railroad.

Wyoming Sulfur Corp. continued planning for an open pit sulfur mine west of Thermopolis in Hot Springs County. Research was done to determine sulfur reserves, and an engineering firm was engaged to construct and test a prototype refining plant. Projected initial plant capacity would be 20,000 short tons of refined sulfur per month.

**Zeolites.**—Tenneco Minerals conducted feasibility and marketing studies on clinoptilolite deposits near Bitter Creek, in south-central Sweetwater County. The mineral is used for catbox filler, in water treatment plants, in radioactive waste disposal and in powerplant scrubbers. About 20 miles of county road would have to be upgraded for access from the deposits to the interstate highway or to the Union Pacific Railroad.

**METALS**

A small tonnage of hand-cobbed beryllium concentrate was produced by Robert Heckert from a deposit in Fremont County.

<sup>1</sup>State Mineral Officer, Bureau of Mines, Spokane, WA.  
<sup>2</sup>State geologist and executive director, Geological Survey of Wyoming, Laramie, WY.

**Table 5.—Principal producers**

Commodity and company	Address	Type of activity	County
<b>Cement:</b> Mountain Cement Co -----	Box 40 Laramie, WY 82070	Plant -----	Albany.
<b>Clays:</b> AIMCOR -----	Box 460 Belle Fourche, SD 57717	Pit and plant --	Crook.
American Colloid Co -----	Box 2010 Belle Fourche, SD 57717	Pits and plants --	Big Horn, Crook, Weston.
Federal Ore & Chemicals Inc -----	609 5th Ave. Belle Fourche, SD 57717	Pit and plants --	Crook and Weston.
Kaycee Bentonite Corp -----	Box 9 Mills, WY 82644	Pits and plants --	Johnson, Natrona, Washakie.
Magcobar Minerals Div., Dresser Industries Inc.	Box 832 Greybull, WY 82426	Pit and plant --	Big Horn.
NL Industries Inc., Baroid Div ---	Box 1675 Houston, TX 77001	Pits and plants --	Big Horn and Crook.
Wyo-Ben Inc -----	Box 1072 Greybull, WY 82426	-----do -----	Big Horn.
<b>Gypsum:</b> Celotex Corp -----	Box 590 Cody, WY 82414	Surface mine and plant.	Park.
Georgia-Pacific Corp -----	133 Peachtree St., NE. Atlanta, GA 30303	-----do -----	Big Horn.
Wyoming Construction Co -----	Box 907 Laramie, WY 82070	Surface mine --	Albany.
<b>Lime:</b> The Great Western Sugar Co -----	Box 5308 Denver, CO 80217	Plant -----	Big Horn.
Holly Sugar Corp -----	Holly Sugar Bldg. Colorado Springs, CO 80902	Plants -----	Goshen and Washakie.
<b>Sand and gravel:</b> Campbell County Highway Dept --	500 South Gillette Ave. Gillette, WY 82716	Pit -----	Campbell.
Casper Concrete Co -----	Box 561 Casper, WY 82601	Pit -----	Natrona.
Fisher Sand & Gravel Co -----	Box 1034 Dickinson, ND 58501	Pits -----	Platte.
McGarvin-Moberly Construction Co.	Box 1166 Worland, WY 82401	-----do -----	Washakie.
Rissler-McMurry Co. Inc -----	Box 2499 Casper, WY 82602	-----do -----	Various.
Rocky Mountain Energy Co -----	1001 Center St. Suite 36 Evanston, WY 82930	Pit -----	Uinta.
Star Aggregates Inc -----	Box 1437 Cheyenne, WY 82003	Pit -----	Laramie.
Teton Construction Co -----	Box 3243 Cheyenne, WY 82003	Pit -----	Do.
Union Pacific Railroad Co -----	1416 Dodge St. Omaha, NB 68179	Pit -----	Albany.

Table 5.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
<b>Sodium carbonate:</b>			
FMC Wyoming Corp -----	Box 872 Green River, WY 82935	Underground mine and plant.	Sweetwater.
General Chemical Co. -----	Box 551 Green River, WY 82935	-----do-----	Do.
Stauffer Chemical Co. of Wyoming	Box 513 Green River, WY 82935	-----do-----	Do.
Tenneco Minerals Co. -----	Box 1167 Green River, WY 82935	-----do-----	Do.
Tg Soda Ash Operations -----	Box 100 Granger, WY 82934	-----do-----	Do.
<b>Sulfur (recovered):</b>			
Amoco Production Co -----	Box 2520 Casper, WY 82602	Plant-----	Uinta.
Chevron USA Inc -----	Box AA Evanston, WY 82930	-----do-----	Do.